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VOLUME 24

JANUARY—DECEMBER, 1938

ST. LOUIS

THE C. V. MOSBY COMPANY

1938

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Printed in the
United States of America

Press of
The C. V. Mosby Company
St. Louis

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American
Journal of Orthodontics
and Oral Surgery

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VOL. 24 JANUARY, 1938 No. 1

Orthodontics

COORDINATION—THE FINAL STEP IN ORTHODONTIC PROCEDURE

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IT CANNOT be emphasized too often that the highest aim of dentistry is the maintenance of the dental apparatus in normal health and function throughout the best part of the span of life.

The systematic study of the dental apparatus of the adult, higher apes, primitive man and those few fortunate ones among us of advanced age who still possess a normal dental apparatus, leads one to the conclusion that teeth ideally situated in normally developed arches will actually serve man throughout the best part of life, barring caries and its consequences.

The Significance of the Anatomic Structure of Teeth and Their Position in the Arch.—The dental apparatus was evolved to a high degree of efficiency for the performance of its various functions throughout life. The teeth are arranged in two opposing and coordinating arches in a manner most suitable for rending and crushing food. The forces which are brought to bear upon them during the process of mastication are directed and distributed in such a manner as to give each part normal function, which tends to the maintenance of normal health, as in all living tissues. Their occlusal planes, plane angles and fissures, curved surfaces and the unbroken contiguity of teeth in the arches tend to guide the food away from the gingival crevices, insuring the health of the crests of the alveoli, the circular ligament and the overlying soft tissues. The teeth, which by virtue of their position in the arch or their occlusal surface extent are subjected to an ostensibly abnormal force of dislocation, are supplied with powerful and long single roots or with multiple roots placed in strategic positions to counteract successfully such tendencies. All roots are tapered toward their apices, so that an impact delivered at the masticating surface of a tooth is transmitted to the entire surface extent of the root or roots and to the

Read before the New York Society of Orthodontists, New York City, March 15, 1937.

whole area of the alveolus enclosing it. There is also a special significance to the fact of flattened and conical roots on all multirooted teeth. The flat ones offer resistance, and the rounded ones yield to applied force. The flattened roots are always the anteriors.

If roots were cylindrical, the whole impact would be transmitted to the apex of the root and would result in early apical absorption, or in driving it deeper into its socket.

The shock of an impact to the masticating surface is further dissipated by the pericementum, which cushions the whole root extent and is reinforced by bundles of tough fibrous tissue. This tissue is anchored in the alveolus and the pericementum, and the whole mechanism keeps the root in a shock absorber-like suspension in the socket.

The enamel layer of the crowns is thick enough and dense enough to protect the dentin and enclosed pulp throughout the best part of life in spite of constant friction, provided the other parts of the apparatus are functioning normally.

My investigations through a stretch of almost twenty years, which have for their object the tabulation and, wherever possible, the elimination of the chain of factors which bring about the untimely loss of teeth, have led me to some definite conclusions.

One of these is that most of the disorders in the dental apparatus and the ultimate loss of teeth, outside of the field of caries and its consequences and also as a result of a few of the grave constitutional disorders, are primarily due to a faulty functional relation of their occlusal or incisal planes and that means their faulty positioning in one, two or all three of their dimensional relations, namely, the horizontal, the vertical and the torsional.

Under normal conditions the forces of mastication are directed against the occlusal and incisal surfaces of teeth in such a manner that they act as a normal stimulant to their investing tissues, which is necessary for the maintenance of tone in all living tissues. If the functional relation of teeth is abnormal, however, this force becomes an instrument of disruption and destruction. Its cumulative effects are the gradual dislocation of individual or groups of teeth; chronic irritation of the pericementum; the absorption of tooth supporting bone in the direction of the abnormal strain; strangulation of the blood vessels in the pericementum followed by degeneration; and finally all the phenomena which precede periclasia.

It is only a matter of time, depending upon the extent of deviation from normal position and the amount of general resistance offered to these disruptive forces by the individual, when these teeth individually and in groups lose their usefulness in the arch. Finally they become a menace to health if they are retained in the mouth.

The malposition of individual or groups of teeth may be due to primary causes, like the faulty or arrested development of the maxilla or mandible, and sometimes both. It may also be caused by secondary adverse conditions, like the too early extraction or too long retention of deciduous teeth. The early loss of some or all of the permanent first molars is another frequent secondary cause.

Let us now examine the fundamental cause mentioned before. The dental apparatus is a composite of two main factors: one a constant, the other a variable. The *constant* is the anatomic shape and size of the crowns of teeth for any given individual. Barring actual physical injury to the dental sack or bud during the developmental period, this anatomic shape and size is predetermined, just like the color of one's hair or eyes, as far as I could ascertain. The *variable* is the shape and size of the bones of the maxilla and the mandible. These two bones like some others in the body are a record of the health chart of the individual. On these adult bones various degrees of ill health, both inherited and acquired, also various degrees of malnutrition and faulty assimilation leave marks of retarded or arrested development, partly compensating acceleration of growth and stages of normal development. Every interference with normal growth ultimately diminishes the length, thickness or height, or all the three dimensions of these bones.

Owing to the fact that the total of the width of teeth in each arch is constant for the individual and that they must be and actually are accommodated in these modified arches, it naturally follows that the first comers, namely, the first molars, incisors, first bicuspids and second molars will occupy their natural positions without interference. The keystones of the dental arch, however, the second bicuspids, canines and third molars, must force their way into these deficient arches, and the dislocation of the previously erupted teeth begins. If the force of eruption and its direction are greater than the resistance to displacement in the previously erupted neighbors, then the latter will be forced out of their normal alignment and crowded one upon the other. If the condition is reversed, the keystone teeth will be diverted from their normal direction; and they will erupt buccally, lingually or torsionally to their erupted neighbors. This diversion of direction may be so great that the entire tooth may develop within the body of the bone and result in a total impaction.

It is then quite obvious that an ideal arrangement of teeth, situated in ideal arches, is very rare in modern child and man.

I shall venture a guess that the specialty of orthodontia came into being primarily to correct unsightly conditions in the mouth for cosmetic reasons only. This specialty in dentistry, however, has grown steadily during my dental career to such a stature that today it is the greatest factor of all dental endeavors in laying the foundation for a normal and adequate dental apparatus. As a general practitioner, I have my share of cases which require orthodontic treatment. I have watched the progress of these cases during and after treatment, and I have seen abundant proof of skill and earnest endeavor on the part of the orthodontists. I also came to the conclusion that the most skillful and willing among you cannot bring all teeth to the exact position you desire and keep them there permanently. I found that frequently you spend more than half your time in correcting newly developed minor irregularities which crop up after the removal of the retaining appliances.

These problems are analogous to the ones I encounter in the mouths of adults when I detect and try to eliminate tendencies which threaten to undermine the health of the investing tissues.

My appeal to orthodontists in general was uttered in 1932. It was embodied in a thesis on preventive dentistry and reads as follows: "This seems to be the proper time to make a plea to the orthodontist. Do not return cases to us as finished just because the teeth seem to be correct in centric occlusion. If there is ever so little an abnormal overbite on the anteriors, your work will be discredited in a few years. This will also happen if the interdigitation of the posteriors is not correct during function. Moreover, even if the functional interdigitation of the posteriors is correct, but not in proper functional harmony with the anteriors, you will have set loose forces against the teeth immediately upon removing the retaining appliances, which will very rapidly set to naught your labors of two or three years. Furthermore, do not consider a regulating case completed before all the third molars are in position, because the eruption of the third molars is usually accompanied by disruptive forces, which are second in intensity only to the period of canine eruption and adjustment in its ultimate position of rest."

This appeal was not intended as a form of criticism of orthodontic procedure. It was made in the spirit of asking for cooperation and by a general practitioner who considers your special field as the first line of defense against the ever increasing tendency to facial disfigurement and masticating deficiency.

I cannot even make a guess as to the percentage of children in the large cities who are fortunate enough to receive orthodontic aid. I do know, however, that it is pitifully low. Knowing the incidence of irregularity in the mouths of children, you can readily understand how poorly equipped the average adult is for the maintenance of his health as far as his dental apparatus has any influence upon it.

Aside from the ravages of caries which we general practitioners find in perhaps 95 per cent of patients who have reached the age of full dentition, there are irregularities of functional articulation ranging from slight canine interference to the complete locking of the bite, so that the slightest masticatory movement of the mandible away from centric occlusion will throw open the bite in the region of the posterior teeth, making these teeth useless for the trituration of food.

I have classified these adult irregularities into four divisions for the purpose of methodical diagnosis and treatment. The first of these and the simplest ought to be of interest to the orthodontist, namely, Class 1, which I define as those forms of irregularity in the adult dentition which can be reduced to normal functional coordination by means of the gradual rebeveling of interfering planes and cusp apices, without impairment to the enamel structure or the normal anatomic outline and efficiency of the teeth.

This class of adult irregularity is analogous to orthodontic cases of children which have reached the stage of retaining appliances and incidentally the age of adolescence and even maturity. It embraces conditions in which there is but a slightly abnormal overbite and the functional intercuspal relations are but slightly deficient and irregular. The examination consists of the observation and recording of the relations of each tooth to its neighbors and opponents and the relation of the whole mandible to the maxillary arch when at rest and in incisal edge-to-edge, canine and posterior edge-to-edge functional relations.

Models are made for record only, for the diagnostic stage and the finished case. They can be of no help in the procedure of reduction.

The patient is gradually trained to move the mandible with teeth in contact, into the various relations mentioned above. When they show dependable efficiency, we begin the reduction of the Class 1 irregularity.

We ask the patient to move the mandible into canine edge-to-edge relation because this is usually the first point of interference with functional harmony. After testing the accuracy of the movement, a strip of thin, sensitive articulating paper is inserted between the teeth on that side, and the patient is asked to occlude in this position and to move the mandible 1 mm. toward centric, repeating the same movement two or three times under the watchful supervision of the operator. This movement will leave a carbon mark upon the most prominent points or interfering planes on the canines, which usually lie on the distal incisal arm or on the incisal border of the distolingual plane of the maxillary canine. These marks are obliterated with a sweeping motion of a heatless stone, which was previously passed through cocoa butter to eliminate frictional heat. This procedure is repeated until the next tooth, usually the distal angle of the lateral incisor, begins to stain. After one or two repetitions on canine and lateral, carbon marks appear on the central incisors also, and from there on the cusps of the posterior teeth show carbon marks in the order of their deviation from the normal vertical position in the arch. This process is repeated on the opposite canine edge-to-edge relation and followed by the posterior edge-to-edge relations on both sides.

Before functional harmony is obtained on the posterior teeth, the molars on the compensating side usually have to be coordinated with them, and this is done in the following manner: A strip of carbon paper is inserted between the molars on the compensating side, and the patient is asked to occlude edge-to-edge on the opposite side. The mandible is moved 1 mm. toward centric as before, then back and forth several times within that range. If any of the posterior teeth on the compensating side are abnormal in horizontal or torsional relation, their interfering cusps or planes will stain deeply, and they have to be reduced to the functional level of the posterior teeth on the opposite side.

If all teeth except the third molars are found fully erupted and there is a tendency toward the separation of the maxillary anterior teeth and a tendency to crowding of the mandibular anterior teeth, the embrasures of the maxillary anterior teeth have to be reduced to the extent to which they show interference with lateral functional movements. This will induce the closing up of the arch in the region of the maxillary anterior teeth if the rebeveling is repeated several times two weeks apart.

The proper incisal edge-to-edge relation cannot be fully obtained until the third molars have taken their proper places in the arch.

The Functional Rôle of the Third Molar.—It is apparent even to the casual observer that the third molars of the adult are rarely in normal position. It is also a fact that the profession at large looks upon the third molars as a nuisance, and they are glad to rid the patient of these teeth under slight provo-

cation. The rôle of the third molars in the dental apparatus is entirely ignored to the detriment of our patients. Contrary to preconceived ideas, the two fulcra of the dental apparatus lie on the third molars if they are in normal position in the arches. The single spheroidal lingual cusps of the maxillary third molars are the pivots, and the central depressions of the mandibular third molars are the runways upon which the mandible moves, tracing a buccally ascending arc on the active side and a lingually ascending one on the compensating side during mastication. This arc becomes straighter and longer with every tooth forward until it reaches the longest and straightest path in the canine region. During normal incisal function the distal cusps of the mandibular third molars slide forward until they reach the summit of the anterior cusps of the maxillary third molars. This combined full height of the third molars is proportional to the incisal functional height of the incisors in normal dentition, and it is designed as a check against shock on the incisors during the last stage of incision of food. Whenever there is imbalance between third molars and incisors in this position, irregularities will soon make their appearance.

If the cusp-upon-cusp position of these molars is too high, the mandibular ones will become loosened and useless early in life; or, if the resistance to injury of their investing tissues is sufficient, there will be found an abnormal gouging out of the central depression and a beveling down of the cusps of the mandibular third molars. If the cusp-upon-cusp position is too short, then there is no shock-absorbing mechanism to prevent injury to the crowns and investing tissues of the incisors. The result is multiple longitudinal cracks in the labial enamel and rapid abrasion of their incisal edges when there is good resistance to injury and dislocation. If resistance to injury is poor, the maxillary teeth begin to separate and spread fanwise, and the mandibular teeth tend toward being crowded more and more upon each other in a lingual direction until some of them lose lateral contact and are pinched in or out of the arch. The foregoing results of the imbalance of the third molar-incisor relation should caution us that this condition must be corrected as early in life as possible. As previously stated, the third molars in civilized man are rarely in proper position. The maxillary ones go through free and uneventful eruption because there is free space behind them and a tapering down of bone formation in this region. The mandibular third molars, however, have a much harder time of it, owing to the fact that at best their eruption is a slow, labored and long process. (I have not made any comparative measurements but primitive man and the primates must have longer mandibles than modern man if one is to judge by their beautifully regular and, as a rule, fully erupted third molars.) As a result of this condition in modern man the maxillary third molars are fully erupted before the mandibular ones emerge; and, as they rise into articulation, they encounter a partly elongated maxillary third molar which will stop it from attaining full eruption or it will force the maxillary opposing one out of alignment, and sometimes the erupting mandibular molar will be deflected lingually to its normal position. If the eruption of these molars is watched, they can often be guided toward normal position by relieving interfering points or planes from time to time until they have attained full eruption and normal relations. If this procedure will become a routine matter with the general prac-

titioner, we shall find a great many more of these most unjustly belittled teeth in the adult mouth and a very important factor of disruption eliminated.

Before closing I must call your attention to two very important facts in this procedure. First, the centric vertical distance between the maxilla and the mandible is never altered during these adjustments because no part of the occlusal surface of any tooth is modified in the position of rest.

Second (this to the men who consider dental enamel as the sacred cow of dentistry), the amount of enamel which is removed at points and planes of interference is so slight and so much in conformity with normal anatomic form that it would take hours of careful inspection to detect the places from which it has been removed. Moreover, the patient would automatically bevel off these surfaces perfectly if teeth were imbedded in a concrete-like unyielding substance. What actually happens is that during the first stages of the automatic attempt to reduce interfering cusps, planes and plane angles this actually takes place, but the abnormal strain upon these interfering teeth produces in a very short time pericemental irritation and bone resorption in the direction of the applied force, bringing in its wake the gradual dislocation of these teeth. This condition is followed by the various types of disorders which tend to the untimely disruption of the integrity of the dental apparatus. In other words, with the rebeveling of these interfering points and planes in a few sittings, precisely and without any injury, we attain the result which the individual attempts to do automatically and through a long stretch of time, but cannot do owing to the vulnerability of the investing tissues when subjected to abnormal strain for any length of time.

It should be a very simple matter for any orthodontist to prove or disprove the value of coordination as a final step in his work. I personally have no doubt about its being the most efficient method of guarding the dental apparatus against tooth dislocation.

576 Fifth Avenue

DISCUSSION

Dr. Mathew K. Klein.—As a comparative novice in this specialty, I cannot permit this opportunity to pass without saying that there is a song in my heart and a feeling of congratulation to this Society for the two papers that were presented this afternoon.

In his discussion of the first paper Dr. Kelsey used a term "traumatic occlusion," and he made a statement which I think is of great import, to the effect that orthodontists always cause traumatic occlusion. Dr. Trattner has proved his contention and compels me to rise to give you a few personal observations of my own.

When I first became interested in orthodontia some years ago, because reluctantly I became convinced that periodontists were failing in their attempt to give the public good occlusion—and after all the purpose of all dentists, whether they be general practitioners who fill teeth and put in bridges, or orthodontists, or periodontists, or whatever specialty you may think of perhaps with the exception of oral surgery, is to secure and maintain as nearly perfect occlusion as possible—I immediately observed a situation such as Dr. Trattner has now presented in these models this afternoon, where cases of very distasteful esthetics were corrected but so far as function was concerned the operators had failed. When I spoke to my associates in clinics and to my teachers in the excellent course which I took, and inquired about this situation, I was told to "Well, just let it alone. Nature will take care of it." The suggestion to grind enamel was an actual anathema to orthodontists. To grind God's enamel was a crime.

I think an orthodontist's work is not done, as we have been told, when the patient is dismissed with the teeth looking quite nice and presentable in appearance. I think that the job must be continued, but the question in my mind is: Is it the orthodontist's job?

An actual correlation of services must be secured by orthodontists and periodontists and perhaps the general practitioner. Should the orthodontist continue his observation of the case, which may be finished at the tender age of fourteen or fifteen years, until the child is twenty-one or twenty-five? Should the orthodontist discontinue treatment all that time, and then when the third molars are completely erupted should he begin this procedure of equilibrating occlusion, or should the patient be referred to the periodontist who is trained to do just that sort of thing, or should the general practitioner who probably sent the patient to the orthodontist originally be instructed to institute the proper procedure to remove interfering cusps and planes? I understand that this question cannot be thrown on the shoulders of the orthodontist. True, I think that the orthodontist has been shirking his responsibilities, but I think the responsibility rests not merely with the orthodontist but with the general practitioner, and if he is not adequately prepared, then with the periodontist. If we are to give perfect occlusion, the specialties of dentistry must combine to that end.

In conclusion, may I add three little points to Dr. Trattner's concluding remarks, in which he assured us that the procedure was not harmful nor unduly difficult? There are three little practical points: One is the magic word "bull"—and it is not funny. What it means is that when you adjust traumatic occlusion, and when you grind the enamel, grind the buccal cusps of the maxillary teeth and the lingual cusps of the mandibular teeth: "bull" so that you will maintain proper occlusion in all excursions of the mouth, and will remove interference, and at the same time not bring the bite closer together, which seems to be the objection that most men voice who are not familiar with the process immediately.

Second, when you are through with your grinding, go over the whole job with very fine sandpapered discs. If you have had it done in your own mouth, you will readily sympathize with this suggestion as the experience of the first two days with roughened enamel is horrible. Third, if you are in any doubt as to how much to remove, remove a little less than you think is actually necessary because you can always take off more if need be.

I hope orthodontists who have been practicing for many years will dispel the prejudice that probably exists in their minds as to such a procedure and really look into it and make it a part of their practice.

RELATION OF FUNCTION TO GROWTH AND DEVELOPMENT OF THE LOWER HALF OF THE FACE

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ANY discussion of the part played by function in the growth and development of the lower half of the face, in the individual, must of necessity involve the question of the interrelation of function and form. The bearing of this question on the science of orthodontia cannot be overemphasized, for the very nature of orthodontic practice depends upon the variations and modifications of structure and the relation of functional activity to these changes.

In attempting a brief analysis of the ideas presented in the literature on this subject, it is my purpose to adopt a true perspective, neither accepting all the various ideas advanced in this field, nor rejecting, on the grounds that sufficient scientific evidence is lacking, certain deductions which are logical and, on the basis of the results obtained, appear to be biologically sound.

The definition of function which limits it to the normal use or special action of an organ or part of a living animal, and in our own field defines the process of mastication as the sole function of the dental apparatus, is inadequate in such a discussion. Modern physiology interprets function as referring not only to the general use of an organ, but also to the intrinsic physiologic mechanism of its parts. Brash[1] makes a useful distinction in referring to the narrower and wider meanings of the word as Function A and Function B, respectively. Johnson[2] has given us the best definition of function as it relates to orthodontia when he states that it refers not only to the process of mastication, but also to all the vital phenomena of the supporting tissues of the teeth and the interaction of these parts in the life activities of the whole organism. Thus, in its broader interpretation, function as applied to our problem must take into account the muscular activity involved in the movement of the jaws and in facial expression; the action, reaction, and interaction of the supporting tissues of the teeth; the problems of use and disuse of the various parts that together make up the masticatory apparatus; and the problem of habits, both normal and abnormal.

Owing to the limitations of time, I shall not include a consideration of the relation to jaw growth of such functional factors as nutrition, the vitamins, and the hormones; but shall merely call your attention to the work of such men as Howard, Franke, and McCollum, which shows that certain factors, some of them unknown, affecting nutrition and the functioning of the endocrine system, have produced clinically recognizable symptoms accompanied by alterations in the facial bones and contours. Nor shall I attempt a review of the changes that take place in the face during its progress toward maturity, for I take it for granted that all of us are acquainted with the work of Hellman, Broadbent, and Todd on this subject. Approaching the subject from the physiologic rather than the

Read at the Thirty-Fifth Annual Meeting of the American Society of Orthodontists, Chicago, April, 1937.

anatomic or anthropometric point of view, I shall merely state briefly the factors to which these changes may be attributed. The increase and the change in proportion in facial dimensions are due to first to the expansion of the orbits, the enlargement of the maxillae and the growth of their contained sinuses, the expansion of the ethmoidal field, the increase in size and definition of the external nose, and the rapid growth of the alveolar processes of the maxillae and mandible in connection with the development of the deciduous teeth and the increase in size of the permanent tooth germs. Later there is a further increase in volume, owing to the need for stronger and larger dental arches, general growth of the paranasal sinuses and their expansion into the bony boundary of the nasal fossae, and the enlargement of the muscles of expression and mastication.[3]

A knowledge of the changes taking place in the face does not in any way explain how or why they occur, or account for the observed facts as most of us see them. Brash[1] has written a paragraph from the philosophical point of view that seems very pertinent. I quote it in full. "To some it may appear probable that if we were in possession of the necessary data we would discover that all the variations with which we are concerned have a genetic basis. However that may be, it is clearly reasonable on general principles to consider environment—including in the most general sense of the word all individual factors external and internal—as the complement of the genetic constitution. We may therefore combine a consideration of how environment enables genetic constitution to express itself with an inquiry whether environment can so modify a 'normal' genetic constitution as to produce structural alterations which have to be designated as 'abnormal.'"

In a more recent paper T. Wingate Todd[4] makes this statement: "Faces differ, and most of us are content to assume that the differences are largely due to the hereditary tendencies implicit in the genes. But as the face, like the rest of the body, is a plastic thing, and since the adult contours are the end-result of a growth pattern which in the course of its progress may be expedited, interrupted, retarded, warped, or inhibited by misadventures of health and by vagaries in the interplay of those organically organized influences by which the pattern is promoted, it is evident that environment, external and more particularly internal, must contribute in no small manner to the final result."

It is evident, therefore, that function in its broader interpretation must be considered a potent factor in the integral growth of the face and its many variations in pattern. And yet one must learn to evaluate hypotheses and theories concerning this relation of form and function, some of which, when first presented, appear so attractive that we are tempted to accept them without further inquiry. Such was the case when in 1911 Oppenheim[5] presented his epochal work on tissue changes incident to tooth movement, in support of the law of transformation of bone as promulgated by Wolff; namely, that "every change in the form and function of bone, or of function alone, is followed by precise changes of the internal architecture, and equally precise secondary changes in the outer form, both in accordance with mechanical laws." Here was a definite statement that the form of bone is determined by function alone. Modern orthodontia was built upon this law of bone transformation. It was not long, however, before the validity of this law was questioned; for the finding that wherever bone pres-

sure and tension occurred bone formation took place, did not coincide with the observations of other investigators. Murk Jansen,[6] for instance, showed by actual demonstration that pressure alone provides the formative stimulus for bone, and that where there is tension alone we find not a prominence of bone, but a groove. Were this not so, fibrous tissue subjected to tension would necessarily be transformed into bone; but, in fact, it remain fibrous for a lifetime. This distinction between the effects of pressure and tension is important in the consideration of the action of the muscles of mastication and expression in the treatment of malocclusion of the teeth.

That the influence of Wolff's law has been far-reaching is evident from the many interpretations of the part mastication plays in changes in facial volume and contour. Not only orthodontists, but also certain progressive manufacturers of dietary and confectionary products have gone on record as saying that the trophic stimuli so necessary for normal growth of bone and the development of the normal facial contours, particularly of the jaws, are not supplied by the usual modern dietary, and that certain products requiring proper chewing, or more chewing, will supply this deficiency.

Waugh[7] in his studies of the Eskimo advances the opinion that the Eskimo's large jaws and regular teeth are accounted for by his unusual masticatory activity. Waugh makes an interesting distinction between the jaw proper and the alveolar border. He concludes that, while the size of the bones may be genetically determined, it is use and action, that is, chewing, that largely determines the shape of the jaws and develops alveolar borders sufficiently large to accommodate the teeth in their normal positions. Whatever degree of truth there may be in this idea, it is difficult or impossible to accept it in full in view of the dietaries of the desert Arabs who live on soured camel's milk, dates and other fruits, and those of certain African tribes* whose staple food is a jelly-like porridge—dietaries that require very little mastication; yet on the whole these people present well-formed dental arches, normally placed teeth, balanced facial features, and well-developed musculature.

Though we may not be able to agree with Waugh's conclusions concerning the relation of racial masticatory habits to variations in facial contour, observations have demonstrated some association between individual and racial habits and changes in the skeleton. Some investigators are of the opinion that variation in muscular activity can affect only the surface form, and not the essential structure. Thus, Darwin noted that in the case of artisans in certain trades the strengthening of a much-used muscle was followed by the enlargement of the tendons and the crests of the bones to which the muscle was attached. Others have deduced a more thorough modification of structure as a result of variation in function. Baker,[8] for example, in a series of experiments intended to show the influence of the "forces of occlusion" on the development of the bones of the skull, demonstrated asymmetrical development in the skulls of young animals after he had ground or cut off the teeth on one side of the jaw. In the realm of pathology there is ample evidence that paralysis or ankylosis, involving a diminution or cessation of function, may be followed by asymmetrical or microdevelopment.

*Quoted by Brash from Rushton, British Society for the Study of Orthodontics, 1920.

Another aspect of the problem concerns the part played by the soft tissues of the face in the development of the surface features of the contained bones. Lourie[9] from his observations of the tongue position in the horseshoe-shaped mandibular arch concludes that, in the growing jaws, when the tongue is allowed to lie habitually on the floor of the mouth instead of being arched against the palate, the resultant pressure over a long period produces an enlarged mandibular arch. Wallace[10] made similar observations, from which he concluded that the tongue helps to coordinate the growth of the dental arches.

Friel[11] also has carried on experiments with the purpose of determining the effect of function on the development of the face and jaws. In his investigations of the maximum strength of different groups of muscles, he distinguishes between dynamic function, with reference to the muscles that move the mandible, lips, and cheeks, and static function, referring to the position of the parts at rest, brought about by an equilibrium of the tonic forces of contraction. Using dynamometers for testing muscular capacity, he made various tests of the different muscle groups. Friel found that severe muscular weakness, though not related to any particular form of malocclusion, is almost always associated with underdeveloped jaws; and that general muscular strength was almost always associated with well-developed jaws and faces, though not necessarily with perfect alignment of the teeth. He found also an association between the strength of the tongue and the arch form: that is, when the tongue was powerful the arches were broad, and when weak the arches were narrow. Though Friel's work was not carried to any great length, and the dynamometers he used did not give perfect indication of functional capacity, his results prove that we cannot entirely dissociate maldevelopment of the jaws from weak musculature.

Rogers,[12] whose work on myofunctional treatment has found so much favor among the more progressive orthodontists, is certainly a proponent of the theory that muscular physiology is a factor in determining the form of the face. In a letter I received from him recently he makes the following statement: "We realize that during the development of the organism, functional tissues are developed to a point where the organism is provided with tissues satisfactorily arranged for the maintenance of life. If at birth these organs, or parts, fail to function, the organism, of course, does not survive. It is in accord with the inherent vitality of the individual that various functional tissues continue their development. If the performance of function chances to be one of feeble nature, the tissues involved may not develop sufficiently to be able to overcome the inherent or environmental interferences. We can consider function then as the normal purposive motor achievement of organs or tissues designed to further growth and development in the organism and the maintenance of organic health in maturity. Functional activity may be feeble, moderate, or strong and adequate, and the resulting development of form will be influenced by whichever of these three degrees becomes habitual for the individual. There are many illustrations to exemplify the truth of the above. Your experience and habits of observation will supply the definite pictures."

Thus, it is Rogers' opinion that structural development achieves its proper perfection if function is performed in such a way as to produce it, and not otherwise. It may appear that such an opinion coincides too nearly with Wolff's

law. Nevertheless, Rogers has proved conclusively that by correcting what he terms malfunction, further maldevelopment can be inhibited, and even that some improvement in arch form can be made.

My own findings have been similar in types of malocclusion associated with sucking habits. Thus, when normal function was established in time, through the breaking of the habit, not only was the maldevelopment arrested but there was a full correction as well.

Fig. 1 shows what Rogers was able to accomplish through myofunctional therapy alone. Some of you may call this "jumping the bite," but it is evident

Fig. 1.

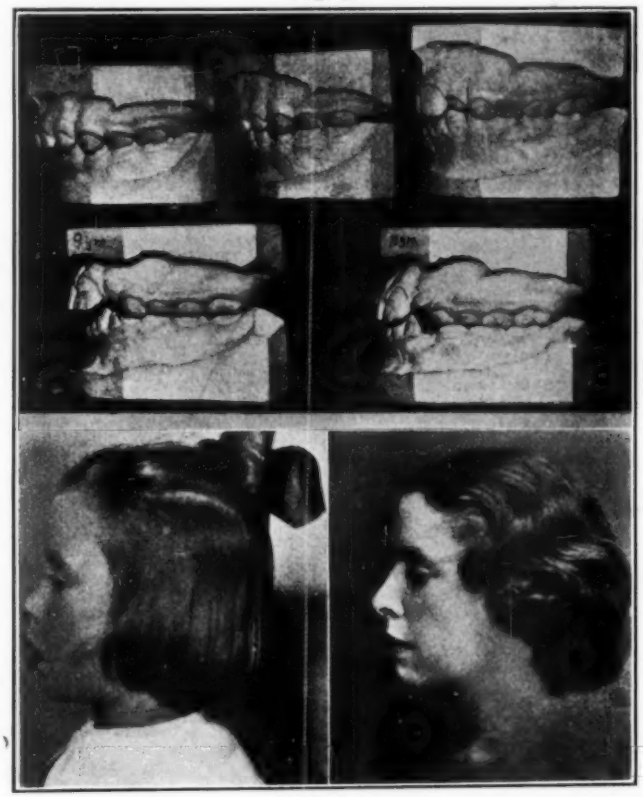

Fig. 2.

Fig. 1.—Models showing myofunctional treatment of distoclusion without the use of appliances.

Fig. 2.—Improvement in facial development and muscle tone. (Figs. 1 and 2 from case records of Dr. Alfred P. Rogers.)

that the facial contour and the occlusion of the teeth were benefited, whether or not we agree that the arch form was changed. It cannot be said with any finality that Rogers has proved the truth of the theory that function determines form, but on the basis of his results, as shown in Figs. 1 and 2, one must admit that he has certainly produced changes in the soft tissues of the face and significantly improved the facial contours. His later work[13] on the behavior of the temporomandibular joint again emphasizes the importance of the part which function plays in effecting and maintaining normal arch relations and in the growth of the associated bones.

Rogers devotes much time to explaining what happens in cases of distoclusion and dual bite, and his conclusions seem sound in view of the fact that there are many variations in the ultimate position of the functioning part of the condyle on the articular eminence. He thinks that the ultimate success in such cases depends not so much on any permanent changes that take place in the muscular or ligamentous attachments as on those parts in which the greatest stress becomes centered; that is, the neck of the condyle. He thinks also that the cephalometric

Fig. 3. Fig. 4.

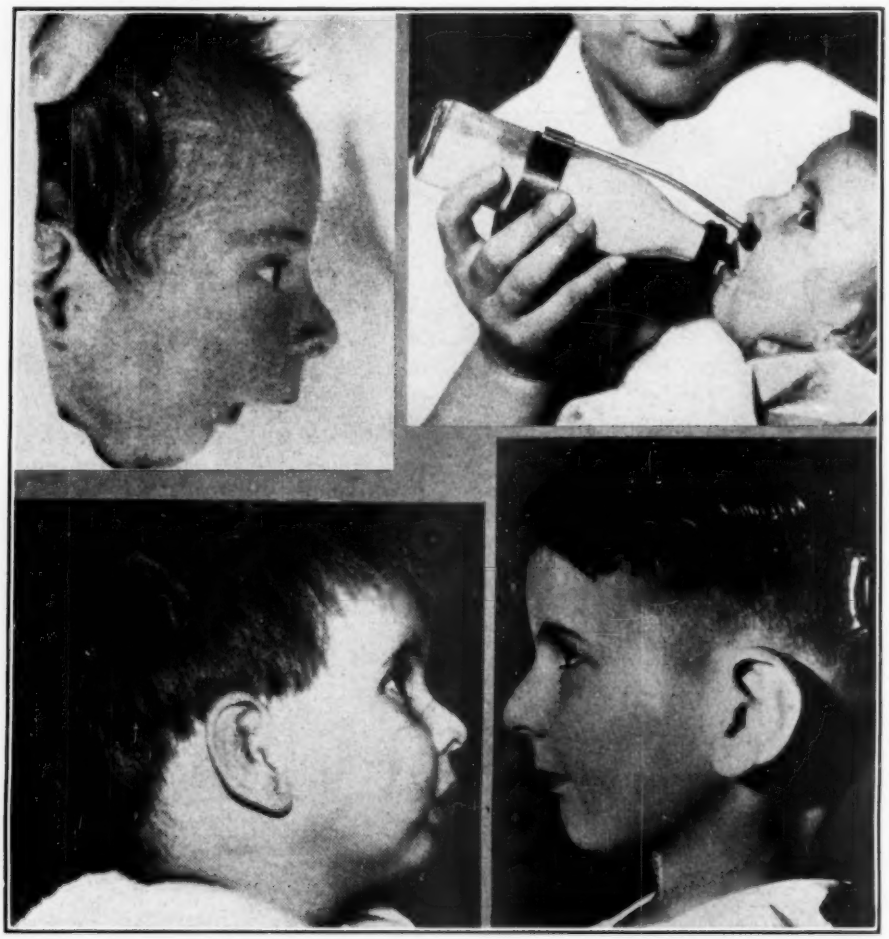

Fig. 5. Fig. 6.

Fig. 3.—Micrognathia in a child three weeks old.
Fig. 4.—Appliance used by Dr. Dunn to intensify vigorous use of organs as originally intended by nature.
Fig. 5.—Appearance of patient shown in Fig. 3 at the age of eleven months.
Fig. 6.—Appearance of patient at the age of three years. (Figs. 3-6, courtesy of Dr. Robert Dunn.)

profile roentgenograms developed by Broadbent will eventually show this change. This opinion seems a reasonable one in view of the fact that in mastication it is the muscles and occlusion which play the important part. Nature seems to allow for many variations in the position of the condyle, whether or not there is a change at the neck.

Carrying the work of Rogers a little further, Dunn[14] (Figs. 3, 4, 5, and 6) reported a case of micrognathia in which he was able to establish function in

the edentulous baby jaws in such a way as to alter completely the growth pattern of the lower half of the face. I first saw this case in San Francisco in 1932. Dunn gave me the privilege of showing it again. The illustrations are self-explanatory. It is clear that the establishment of the function of sucking has brought about a change in facial contour and has overcome whatever was the impediment to normal growth of the face. This change is illustrated in Fig. 6,

Fig. 7.

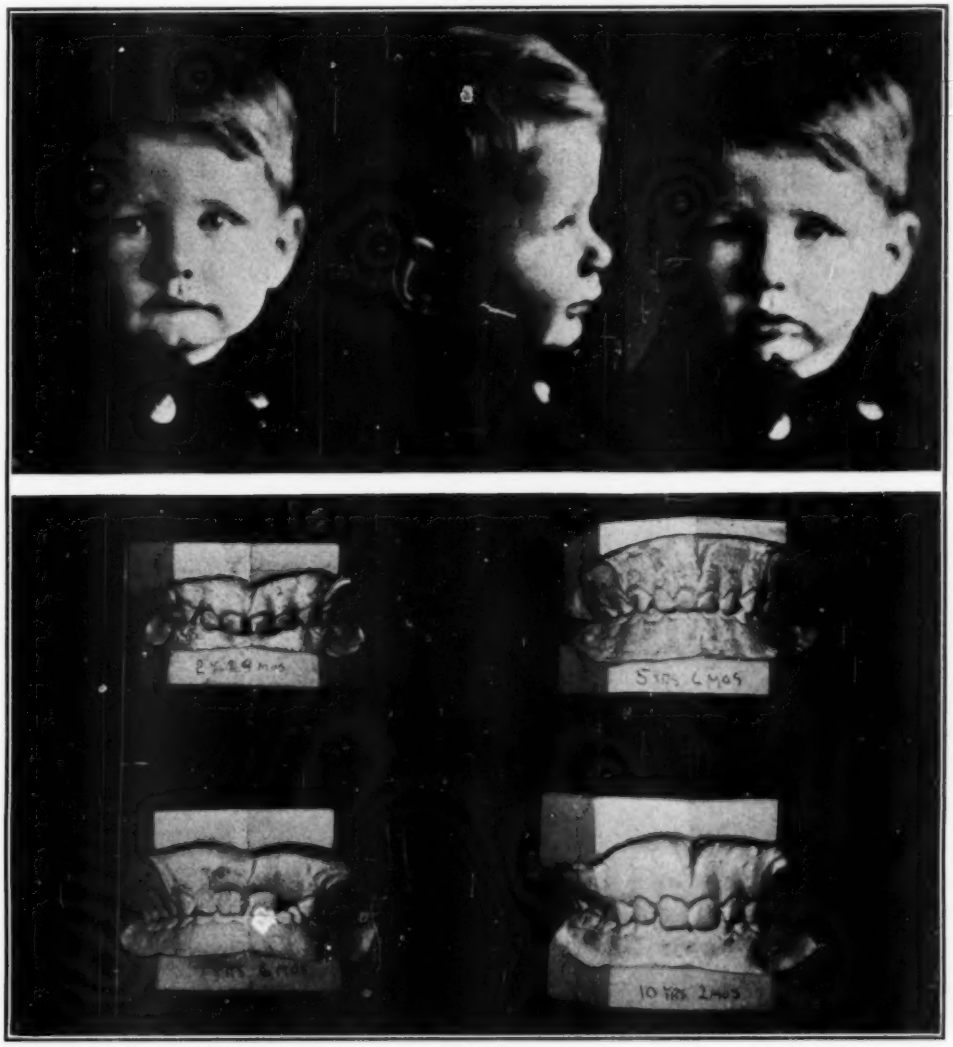

Fig. 8.

Fig. 7.—Three views of lip-sucking patient aged two years and four months.

Fig. 8.—Successive models of the lip sucking case shown in Fig. 7. The only treatment was breaking of the habit.

sent to me only recently. Here again is an illustration of an environmental factor acting as a complement of the genetic constitution.

I have already made some mention of the relation of such habits as thumb-sucking to the growth and development of the lower face. It is probably evident to all of you, on the basis of your own observations as well as such reports as I have made, that such habits may alter the face pattern. Though certain

articles have been appearing regularly in the lay press to the effect that thumb and other sucking habits are harmless, and that only rarely is such a mechanical force responsible for a malformation, there is evidence to the contrary. It appears, from such evidence, that breaking the habit as early as possible, in accordance with sound psychologic principles, is the proper procedure in such cases. It does not seem necessary to review my findings on the spontaneous correction of malocclusions associated with thumb-sucking, when the habit is broken early enough, and the beneficial effect on the facial pattern, but I should like to present a case which I have had under observation for the past ten years. Figs. 7 and 8 show the models and photographs of a boy who was a persistent lip sucker. It is evident that all is not right with the genetic mechanism. After about a year of effort on the part of the mother and the consulting clinical psychologist, the

Fig. 9.—Face of boy shown in Fig. 7 at the age of ten years and four months. No appliances were used in this correction.

habit was broken. Subsequently, nature made a good attempt to correct the faulty development. While the maxillary first permanent molars are slightly rotated, the arch form and the occlusion are certainly close to normal. Fig. 9 shows the face of the boy, from a photograph made a month ago. I think you will agree that he has a fine face. Certainly it is superior to what it would have been had not function been established by extraneous means. In such a case, the improvement in facial contour should be attributed not to the establishment of normal occlusal relations, but to the establishment of normal functional activity of the dental apparatus.

In conclusion, may I say that, while as yet we have relatively little proof of the part played by function in determining the growth and development of the face, clinical observations indicate that in some manner and in some degree function, broadly defined, plays an important rôle in furthering or impeding the inherent factors that produce the adult facial pattern.

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RHINOLOGIC FACTORS INVOLVED IN THE DEVELOPMENT OF THE LOWER HALF OF THE FACE

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OUR children require air and food to live. Air must come in through the nose, food through the mouth. Vitiated air must come out, but without any unusual odor or effort; food must stay down after proper mastication. If we can attain these prerequisites, we shall give our children a chance to develop properly by eliminating deleterious influences, either by prevention or by treatment, and they begin life's struggles with at least half the battle won. Hence, we who look after the welfare of the nose and the mouth stand at the fountainhead of all good and at the spearhead of all evil.

The work of T. Wingate Todd and his associates, in graphically demonstrating the factors which influence the growth and proper development of the lower half of the face, makes my problem comparatively simple. They have proved during a study covering seven years that "it is possible to construct norms of facial growth at any period of childhood, and it is likewise possible to study both the origin and the course of deviations from the norm." To us rhinologists, who are interested in the scientific study of nose and throat conditions in their relationship to the proper development of our children as a whole, this research should be of inestimable value.

Todd also states "that everyone knows, of course, that faces differ, and most of us are content to assume that the differences are largely due to the hereditary tendencies implicit in the genes. But as the face, like the rest of the body, is a plastic thing and since the adult contours are the end-result of a growth pattern which, in the course of its progress, may be expedited, interrupted, retarded, marked, or inhibited by misadventures of health and by vagaries in the interplay of those organically originated influences by which the pattern is promoted, it is evident that environment, external and more particularly internal, must contribute in no small manner to the final result."

Others who have contributed to our knowledge of the fundamentals in the growth pattern of the face, such as Hellman, Rosenberger, Pitkin and Howard, give the clinicians a scientific background on which successful results can be predicated.

This paper, by a practicing rhinologist, takes advantage of the proved facts, but cannot enter into a discussion of other factors such as nutrition, endocrine imbalance, vitamin and mineral salt disturbances. Todd's work referred especially to allergic involvement of the upper respiratory area and to adenoids. I shall refer at length to these and hope to review other conditions, which are either pathologic in origin or due to abnormal anatomy.

Read at the Thirty-Fifth Annual Meeting of the American Society of Orthodontists, Chicago, April, 1937.

The layman thinks of nasal obstruction, in children, as due only to adenoids. It has come to be used as a generic term. To us any interference with proper breathing should recall the many conditions which cause blockage for long

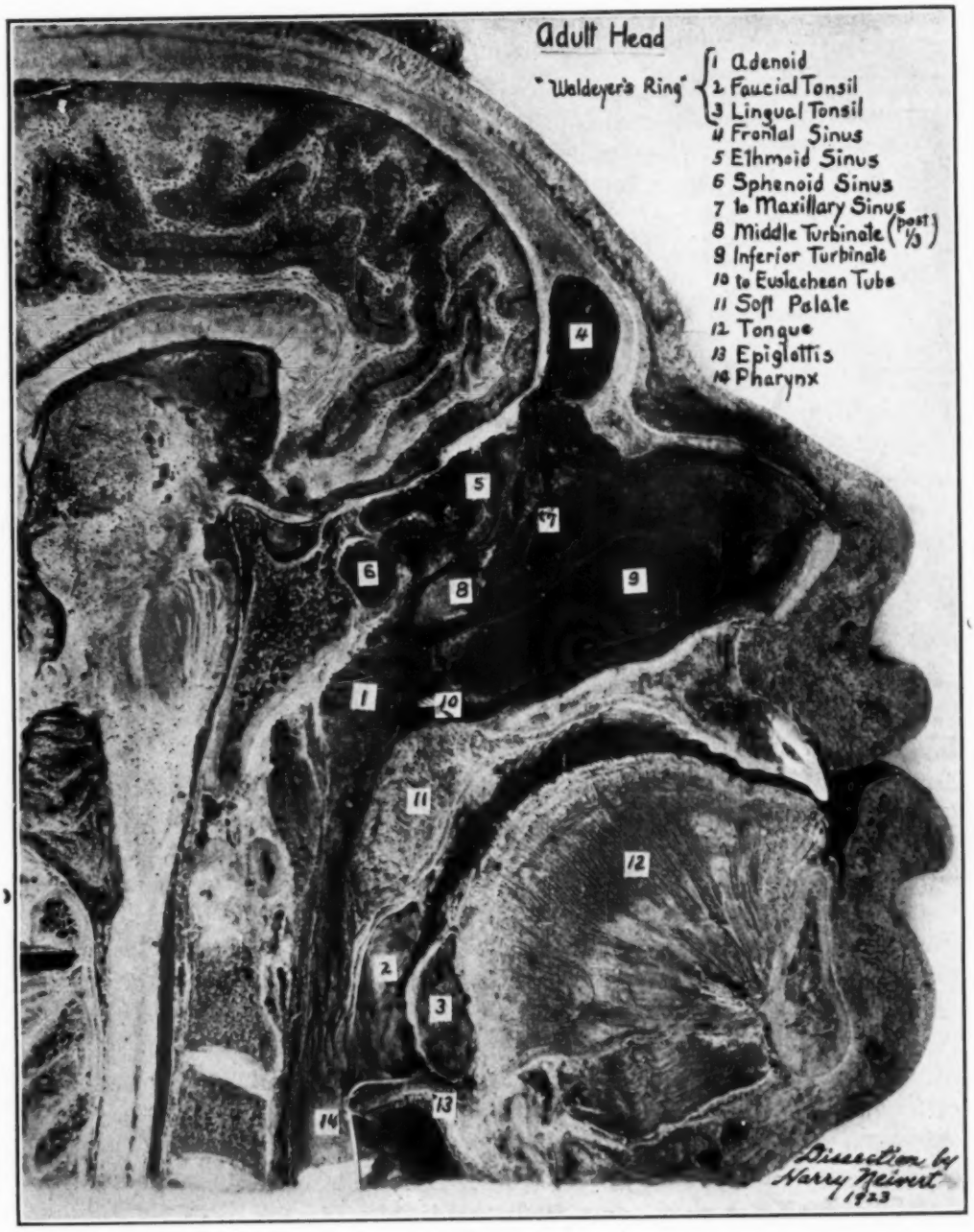

Fig. 1.

periods, or those that are more or less permanent. The nose may be a small organ when compared, for instance, with the chest or the abdomen, but the great variety of pathologic manifestations which may develop there, the relative inaccessibility for correct diagnosis and treatment, and the fact that it is at the

gateway to the inner organs, make its importance paramount in the consideration of upper respiratory affections and a great many general systemic disturbances.

When we talk about the nose, we mean not only the external protuberance which acts as a canopy or subway kiosk, but the internal structures—the septum, turbinates, sinuses, pharynx, adenoids and tonsils. We should include the eustachian tube, middle ear and mastoids because they are practically another group of air cells akin to the nasal sinuses and are more or less involved at the same time that the nose itself suffers.

Most nasal as well as upper pharyngeal abnormalities get little attention from parents and physicians because they do not cause pain. This statement can not be emphasized sufficiently. In this fact lies, what I believe, the greatest cause for morbidity in the realm of medicine. All of us are "catching cold" or, as the English say, "taking cold," at some time or other. We consider it normal to have from one to four colds a year. These colds are definite entities, more scientifically called acute rhinosinusitis. They are contagious, as you well know, and therefore the English use the term "infectious catarrh." These repeated attacks, if prolonged and untreated, result in hypertrophic enlargement of the turbinates and nasal mucous membrane, aside from many other sequelae to be discussed later.

St. Clair Thomson gives us a very simple definition of the pathology involved in the upper respiratory tract. "Catarrh is the name given to the inflammatory reaction on a mucous surface, by which the body defends itself from an invading organism or irritant substance. This reaction is characterized by increased hyperemia and increased leucocytosis. Abundant mucin, cast-off mucous cells, and some leucocytes are poured out on the surface, forming a 'catarrhal inflammation.' If more leucocytes are stimulated to extrude themselves on the surface of the mucosa, the condition becomes one of 'mucopurulent inflammation.' If the reaction is more severe, with complete destruction of the mucous membrane proper, the leucocytic exudation tends to favor a deposit of fibrin on the surface and we get a 'membranous inflammation.' More severe destruction produces 'ulceration.' If there is a tendency for the process to invade the submucosa, the latter becomes infiltrated with pus, this form is called 'phlegmonous inflammation.' In chronic inflammation there is the same increase in hyperemia, cell nutrition, and migration of leucocytes, but to a slighter degree, while it also leads to a proliferation of connective tissue cells." Here lies the most important cause of our trouble; the increase in connective tissue cells which result in permanent swelling of the mucosa and, therefore, blockage of the nasal passages.

A factor of great importance in the causation of nasal pathology, which few of us have time to think about, is due directly to our advanced civilization. I refer to the improper humidity of the air in which we are compelled to live and work for a large part of the year. Our heating systems have long been known to reduce the moisture in the air we breathe, throwing a great, sometimes overwhelming, burden on the nasal mucosa. One of the important functions of our noses is to furnish water to the inhaled air as it circulates around the turbinates before being drawn into the larynx. Physiologists tell us that this amounts normally to at least 1,000 c.c. or a quart in twenty-four hours. How much more

the demand is in dry hot rooms, it is difficult to say, but there comes a time when the mucosa becomes exhausted and dries up and the pathologic results certainly do not benefit us. There will come a time in the near future when this factor will be greatly ameliorated, when efficient humidifying apparatus will be cheap enough to be within reach of the average home. Then the nose will not be so sensitive and we will have fewer colds.

I cannot emphasize too strongly the fact that physicians are, to a great extent, to blame for the chronic afflictions in the nose and adjacent areas. They pass over all too lightly the so-called mild symptoms of recurring colds or sinusitis and seek the aid of the rhinologist only when there is severe pain, serious complications, or permanent damage. The public has learned to fear the term "sinusitis" because to most people it means an incurable disease. It becomes tragically comic to have people exclaim, "Oh, doctor, don't tell me I have sinus trouble." Today, when we tell a mother that her child has sinusitis, the shock is frequently overwhelming. It is almost as bad as telling her the child has tuberculosis for her thoughts immediately picture a family disrupted—the child and the mother in Arizona and an expense which to most is impoverishing. To the rhinologist, sinusitis is just as easily curable as tonsillitis or any other nonfulminating infection. By proper treatment, which is extremely simple, painless and nonsurgical, almost all cases are quickly brought under control and readily cured if seen early enough.

As scientific men, I feel you should know the simple truth about sinusitis and its sequelae and impart it to your patients. Every cold is a sinusitis, varying in degree from a slight snuffle to excruciating pain and blockage of the nasal passages permitting no drainage from the sinuses. The mild cases generally clear up with little or no attention. If there are no frequent recurrences, nothing further need be done. But repeated attacks call for an investigation of the cause, because the end-result of frequent infections of mucous membrane is thickening of the entire lining of the lower half of the nasal passages. This narrows the respiratory area, and there is more or less constant and permanent blockage.

Now let us see how this hyperplastic condition comes about. Very simple, if you recall the sequences of pathology as stated a few moments ago. When one is suffering from a cold, the entire nasal and sinus mucosa is involved. It is a striking realization to most people to learn the enormous area covered by respiratory mucous membrane. All this is diseased. The degree of inflammation depends primarily on the strength of the invading organisms and the resistance of the host. The result is modified by the anatomy and the previous pathology. If the ostia of the sinuses are patent, drainage takes place quickly and nature heals the infection. I must repeat—*nature heals.* We have no medicine which taken internally or when applied locally, if such were even possible, cures sinusitis. If we get air into the sinuses, drainage takes place. For the two cardinal principles in treating sinuses are to get ventilation and drainage. All treatment, all operations, are designed to get these two results. If such does not take place, the nasal mucosa may subside to some extent but the sinus mucosa, by continuing to pour out an irritating secretion, pus, keeps up a chronic inflam-

mation which results in hyperplasia not only of the lining of the sinus but of the turbinates and the rest of the mucosa in the lower nasal passages.

This brings us now to another part of the nose seldom associated with it by the layman and many physicians; the eustachian tube, middle ear and mastoid cells. These are more or less involved in many cases of sinusitis and adenoid hypertrophy. I like to consider these structures as another group of sinuses, for, indeed, are they not air containing organs—even lined with a modified form of respiratory mucous membrane? They are not placed very advantageously in regard to drainage, so nature has provided a by-pass valve—the tympanic membrane or drumhead which we can open when there is an accumulation of serum or pus in the middle ear or drum, and the mastoid cells. It is well to remember that every so-called abscess of the ear is an inflammation of the lining of the eustachian tube and mastoid cells as well as the middle ear. In severe cases the mastoid bone may be very tender to pressure, and there is a beginning involvement of the bone itself. Even then, there may be resolution and complete healing without an operation. When, from careful study, it seems in all likelihood that nature will not heal the infection, it is well not to delay operation too long for two main reasons; first, the danger of complications to meninges, brain and lateral sinus and all the rest of the body; and, second, the almost certain loss of hearing from prolonged suppuration, causing destruction of the drumhead, ossicles, and other minor structures in the middle ear.

What a handicap deafness is—especially in the young. We know, definitely, that adenoids and sinusitis, working together, are the paramount causes. So, besides thinking of these two as interfering with proper development of the jaws and teeth, give some heed to the possibility of preventing deafness by proper and early attention.

Another important factor in nasal obstruction is the septum. Once the deformity develops, it is permanent and becomes part of a vicious circle. On one side the nasal passage is generally larger, and in this side the turbinates hypertrophy to compensate for the extra roominess. In the other side, being more or less closed, there results a train of pathologic sequences which may run from sensitivity of the nose and frequent sneezing spells to serious involvement of the sinuses and ears.

Almost all of us have some deviation of the septum. The cause is often difficult to trace, but in most cases it results from trauma. Among the earlier investigators some attention was paid to rickets and syphilis as a cause, and racial characteristics were studied. It seems that all are agreed that septal deformities are more frequent among civilized than among savage races.

Trauma, as the main and perhaps the only cause, is borne out by the fact that septal deformities are so much more frequent in males and especially more common during the school age—increasing rapidly from the age of six to seventeen years. There are many other explanations and theories which need not be discussed here. We know that a child is constantly liable to injure its nose, and a blow or a fall causes several things to happen which readily explain the deformity. The septum has three main components: the lower basal and posterior is the vomer—the thickest and the least subject to injury. In an examination of many hundred skulls, I have always found the posterior edge, which divides

the posterior half of the nasal chamber, in the midline. Its upper edge may show thickening where it articulates with the perpendicular plate of the ethmoid and with the quadrilateral cartilage. The latter two are much thinner and are so set on the vomer that they are easily dislodged by a blow or a fall. There necessarily follows some degree of fracture and dislocation with hemorrhage between the mucosal layers which may completely close both nasal passages or may result only in a moderate swelling. Sometimes this clot is absorbed and leaves more or less deviation or deformity. At times the clot becomes infected, and there is a serious condition which, if not treated properly, will result in a saddle-nose besides the internal deformity. The cartilage is very sensitive to both infection and pressure and readily undergoes liquefaction necrosis. This is absorbed and replaced by scar tissue such as happens in a similar condition which is known as cauliflower ear.

We see many cases in which the cartilage has bent to a right angle, closing the anterior nares more or less completely. This causes chronic infection of the sinuses and such sequelae as discussed before. I plead with you not to permit these cases to go without proper attention as early as possible.

After an injury to the nose, it should be examined by a competent rhinologist. If there is any displacement of the septal element, it can be replaced very readily, with or without anesthesia and with a minimum of instrumentation. This should be done, without delay, before there is too much swelling. If the patient is seen at any time after the primary stage of swelling has subsided, leaving a deformity of the septum, then surgery should be advised. The old teaching was to wait until the patient was seventeen years old. This permitted, in many cases, irreparable pathology to ensue. This admonition was due to the fact that the standard operation for submucous resection of the septum necessitated the removal of the cartilage or bone, often with disastrous results. We have, today, several methods of plastic operation whereby the septum is straightened without removing any of the cartilage and at the same time the nasal tip is raised. The result is a patent nasal passage which permits the proper functioning of the nose.

We now come to the nasopharynx where the most important structure, which may cause obstruction to proper breathing, is the adenoid or pharyngeal tonsil. We generally think of it as one mass, ovoid, with surface corrugated and cryptic. We should remember that there are prolongations from the main mass into the eustachian tubes and down the pharynx where it meets the true tonsil, also called the palatine or faucial tonsil. Finally, at the base of the tongue, we find the lingual tonsil. This whole series of lymphoid follicles is known as Waldeyer's ring. With every cold or sinusitis all the follicles are more or less involved, and in those children who have large adenoids, the eustachian tubes may be completely blocked off as well as the posterior choanae, so that there is no interchange of air in the nose and sinuses anterior to the adenoid, and in the tubes posterior. There then follows a series of pathologic events ranging from simple blockage to serious involvement leading to a fatal end.

In this paper, I do not deem it necessary to discuss, at more detail, the symptoms and signs of adenoid hypertrophy. In my discussion of Todd's

paper given before the American Society of Orthodontists in April, 1935, and previous to that, at the meeting of the New York Orthodontic Society in October, 1933, I tried to review the facts known to most of you. I emphasized certain signs and symptoms by which the presence of adenoids could be recognized. The results of their persistence you know well. I merely wish to urge you to think of the possibility of adenoids as the cause of frequent colds, nasal blockage, ear infections, and deafness—besides its effect on retarding growth of the jaws and teeth.

The last item for discussion is allergy—that almost mysterious something which makes people become sensitive to certain foods, inhalants, drugs, pollens, animal epidermals, and many other things. These allergens are proteins with which we are in constant contact by way of the skin or the mucous membranes of the respiratory and gastrointestinal tract. Why we are affected at any particular age it is impossible to say. Symptoms may manifest themselves any time from birth to old age. No matter what part of the body is affected, the nose sooner or later becomes involved in a great many cases.

We have proof of hereditary influence in about 70 per cent of cases. The type of allergy will not necessarily be the same in all. For instance, a father may have asthma and the child may have eczema or hay fever. The most common forms in children are due to food sensitivity which affects the gastrointestinal tract, and generally there is more than one food. The causative food, contrary to the belief of many, is one normally well tolerated and wholesome. It may be well cooked or raw, a common article of diet or an unusual one. Those sensitive to rare foods are fortunate in that they readily learn to avoid them, but since most allergic children are sensitive to several commonly used foods, their problem becomes serious. As the child grows, he usually loses his sensitivity to foods, but is apt to acquire other forms of allergy. An infant who refuses certain foods may have an instinctive repulsion for them and should be suspected of being allergic.

The symptoms which should make one suspicious in children are blistering and swelling of lips and mouth, often followed by vomiting, diarrhea, cramps, and even shock. Canker sores and vague abdominal symptoms which persist for a long time should be investigated. Many patients have been operated on without benefit for suspected appendicitis or gallbladder colic, while others are dismissed as neurotic. Some cases of pruritis and all types of urticaria or "hives" require allergic study.

Reactions to foods may take place in practically any tissue of the body. Rowe, in a study of 300 food-sensitive patients, found the following reactions: abdominal in 79, migraine in 46, asthma in 83, urticaria in 28, eczema in 26, and angioneurotic edema in 18. In 48 per cent of these cases positive skin reactions were obtained and food dislikes or disagreements in 59 per cent.

The production of nasal symptoms as the result of ingestion of foods has been definitely proved by positive skin reactions or elimination diets. Freedom from symptoms has occurred on the exclusion of the particular food indicated, and symptoms have reappeared on its reinclusion. Eyerman (1930) described

95 cases of this type; 8 of the patients were sensitive to one food and 87 to more than one food. Of these, 89 gave positive skin reactions, the most common foods being wheat, egg, milk, chocolate, potato, and stringbeans. As these patients also manifested other allergic reactions, such as hay fever, due to pollens, or asthma, due to epidermals, the added irritation from the food increased the severity of the symptoms.

Rowe found that in 50 consecutive patients whose main symptoms were seasonal hay fever, half gave a positive history of perennial nasal congestion. Children with continually running noses are frequently relieved by elimination of offending foods, and the other allergic manifestations are apt to clear up also.

The allergic disease in which we are most interested is pollen allergy because it directly affects the nose. This is a common condition known by many names—"rose cold," "hay fever," "summer catarrh," "autumn catarrh," and many others. For varied periods of time, the nasal mucous membrane becomes swollen, edematous and pale, blocking the nose completely. The true seasonal type, lasting from a few weeks to several months, in itself may be serious enough so far as it produces long continued nasal obstruction; but there are added complications, such as sinusitis, lack of appetite, loss of smell and poor digestion, all of which retard the general health and naturally interfere with proper nutrition to bone and teeth.

It may interest you to know why hay fever symptoms vary from year to year or from day to day. Sunshine is a stimulus to pollen production, so the amount on cloudy days is relatively poor. Temperature is an important factor; below 60° F. all pollination ceases; a temperature of 75° is necessary to open the flowers, so that the anthers may empty most of the pollen at once by turning completely over. Some open in the morning and some at night. Rain has two effects: the pollen settles down and there is less production. With increased humidity, there is an increase in symptoms. Wind is an important but variable factor: the velocity and direction and time of day determine the amount coming in contact with the patient.

It is most unfortunate that in children pollen allergy is generally misdiagnosed as a common cold and is permitted to go on with improper treatment. The persistent sneezing and running eyes and nose are but rarely seen in children, and the constant mouth-breathing is laid to adenoids and is not benefited by operation. The first symptoms may follow some long exposure, such as a long car ride or a picnic or a stay at a summer camp. Some times as a rare coincident, it may follow an operation, such as a tonsillectomy, and the physician is blamed for the fact that the child has had constant colds since. And, added to the seasonal type, there is the perennial so-called allergic rhinitis, or vasomotor rhinitis, aggravated by such as dust and orris root plus other sensitivities which add insult to injury. Allergy, in all its various manifestations, whether in the nose, as hay fever, or lungs, as asthma, in the skin, as urticaria and eczema, in the brain as migraine, and in the gastrointestinal tract as ulcers and colic, plays such an important part in the development of our children that it behooves us all to learn to recognize its presence and seek aid in its relief.

SUMMARY

I hope that in these rambling jottings I have conveyed to you a few thoughts which concern both the orthodontist and the rhinologist. I hope that we can be of some help in aiding you in getting better results in your mechanical efforts to bring the teeth to their proper position and so to change the jaws that the face will have a more normal appearance, and, last, so that mastication and proper preparation of food for gastric digestion may help in the development of a healthier race. A proper nasal and pharyngeal passage can be had and maintained by every child if we but remember the few conditions which we have discussed. Physicians are *preaching* preventive medicine. Here is a chance to *practice* it.

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222 WEST SEVENTY-SEVENTH STREET

CLINICAL ORTHODONTIC EVIDENCE OF SYSTEMIC DISEASE

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GENERAL systemic disturbances may seem but remotely related to the every day problems of the clinician of orthodontia. The significance of the relationship becomes clearer as we review the development of the science. It is not so many years ago that the profession and the laity began to be impressed with the remarkable changes in dental and facial relationships produced by a few skillful practitioners who had devoted attention to this specialty.

The results they obtained with devices which they recognized as crude and imperfect prompted them to direct attention to improving and perfecting the mechanical means for tooth movement. Fortunately some of these men were fortified both by training and by mental aptitude with biologic background that often unconsciously directed their efforts. The profession at large, however, saw chiefly the mechanical devices. They were men living in an age of mechanical invention and trained rather largely in schools of dentistry which at that time had not yet begun to chafe under the shackles of mechanical concepts. It is small wonder then that arguments grew hot and sects based upon mechanisms for tooth movement developed.

With the leveling influence of time and the sobering judgment which comes with increasing years in a profession as well as in an individual, men began to compare results, to study mechanics more academically and less as a cult. With this study certain of the biologic principles which guided earlier leaders again came to light with renewed significance. Orthodontists began to realize that there is more to tooth movement than appliances. The goal which they had sought was not attained, even though they were skilled in the manipulation of both intricate and efficient mechanisms for the moving of teeth.

By this time men were saying that the reason for their failures lay in diagnosis. The mechanical development had taught them to know what could be accomplished in some cases; still their results were not consistent. This, they said, was because they had not analyzed their problems accurately. They did not know what they wanted to do even though they had the means with which to do it. There followed then much controversy, some of which still rages over methods of diagnosis.

All this discussion, investigation and analysis has not been without progress, for it has stimulated means of relating the plaster cast to the cranium through the work of Simon, and it gave impetus to the study of dentocranial relationships which are made possible through the methods developed by Broadbent in this country and by Hoffrath, Korkhaus and others in Europe.

Read at the Thirty-Fifth Annual Meeting of the American Society of Orthodontists, Chicago, April, 1937.

We became conscious of the temporomandibular joint and can study this area by means devised by Higley and Risner. Brodie contributed valuable clinical criteria and diagnostic suggestions. More recently we have been made conscious of the movements of mastication and functional tooth relationships as well as tooth interdigitation by Maxwell and those who, though disagreeing among themselves, are seeking a common objective.

At the present we are in possession of mechanical devices which, if skillfully manipulated, will give effective control of tooth movement. We have at our disposal accurate methods of determining dental, interdental and dentocranial relationships before, during, and after treatment. Still our goal has not been attained. Our percentage of successes is perhaps greater, but our failures are discouraging. Our improved methods have shown us that we often fail in accomplishing our objectives. In too many cases our results are destroyed after they seem to have been attained. There are few men of experience who have not been disheartened by viewing cases apparently well corrected, years later when conditions were much as they were at the outset.

With this background it would appear that there is after all some reason to study the patient as well as the region to which our activity is directed.

Perhaps no other part of the skeleton is more sensitive to systemic disturbance than the face. For complete normal development not only is it dependent upon the growth of its many components, but this growth must be harmonious and synchronized. Each part must develop and increase in size at periods which are coordinated with the same process in all other facial units if harmonious and functional perfection is to be attained.

Moreover, these elements in the skeletal architecture of man are relatively recent phylogenetic developments and perhaps for this reason less constant than the development of a femur for instance. In this respect the denture which is so important a part of this complicated picture offers a very good example.

Finally, the adaptation of the bony framework of this area to the many distinct and varied functions which depend upon it offers further complications. Sight, hearing, speech, mastication, respiration, and deglutition all affect and are affected by one another. This tends to destroy the simplicity of growth and development which prevails in many other areas.

It is probable that a serious arrest in development in any part of the skeleton is never completely compensated subsequently. The simpler the structure and the smaller the disturbance the less is the resultant handicap. When we apply this principle to the face, which needs not only complete development of its parts but development at appropriate times for fulfillment, we begin to appreciate the reason why malocclusion is a common rather than a rare occurrence. It is probable that the imperfect timing of the units of facial growth and development is as important as any single factor contributing to these anomalies. A humerus may be interrupted in growth with little relative serious effect upon the femur, but when the maxilla is affected so must be the palatine bone, the vomer, the zygoma, the maxillary denture, through this the mandibular denture and the mandible.

Not only is it necessary for growth and development to pursue an uninterrupted course, but the component of the growth impetus which is supplied by function must approach the optimum and remain above minimal limits. Function offers a contribution to growth. If this contribution is lacking or perverted, the affected part does not reach its potentiality. The identical factors which require a harmonious growth and development of the face demand a harmonious function.

With these matters in mind we may approach the clinical significance of the presentations which have preceded this paper. Embryological, growth and developmental, endocrine, and nose and throat disturbances which affect the individual are frequently recorded in the face. Because of the sensitivity of the region many conditions too insignificant to elicit concern as clinical entities evidenced in other parts of the body occur with sufficient degree or at appropriate times to affect seriously the harmonious development of the face. Few if any of these conditions can be considered as pathognomonic of the etiologic factor.

Endocrine disturbances may retard or accelerate growth and progress toward maturity. But these same processes may be affected by nutritional disorders, by infection, by congenital defects, congenital inferiority and a host of other conditions. In particular instances it is difficult and more often impossible to diagnose the disturbance from the deformity. The orthodontist can often direct attention to these evidences the determination of which rightly falls within the province of medicine. Unfortunately, because of the sensitivity of the face to delicate derangements, the orthodontist's discovery cannot always be corroborated by the physician who forms his opinion by appraisements of structures and functions less easily disturbed, or because the limits of normal variation have not been trimmed to sufficiently fine margins.

The disturbances through which much of the practice of the orthodontist arises are so-called subclinical disorders. His patients are in the main considered healthy by the physician. Their malocclusions have developed because there has been a temporary arrest in the normal pathway along which the individual travels toward his optimum development, because there has been a disturbance of function, because there has been so delicate a persistent deterring factor that it does not give rise to the gross manifestations of disease.

The Eskimo child of whom Dr. Waugh has shown frequent illustration is a good example. He has the potentiality of a good denture but through a change in environment, nutrition and function a facial deformity develops, yet his general physique which may also be affected if more carefully scrutinized passes as normal. The success which Dr. Rogers has described in the use of myofunctional therapy further illustrates the thesis from the standpoint of function.

If we are content with obtaining satisfactory results only in those cases which would have developed without treatment or in which the principal etiologic factor is no longer operating and the patient normal in growth, development and function, we need not be concerned with these subclinical handicaps. If, on the other hand, we are to practice orthodontia as oral

orthopedics, which it truly is, we must refine our concepts of the healthy child and take cognizance of our findings.

Investigations of this character are already in progress. The criteria which are being elaborated by the Associated Foundations at the Department of Anatomy at Western Reserve University, the Council of Child Research in Denver, the Growth Studies conducted at Harvard University, the work of the Merrill Palmer School in Detroit, and many other organizations, are making an attack upon the problem. The data which they accumulate for us will enrich our armamentarium. With these data, combined with our developing diagnostic criteria, information of clinical importance may be obtained which will assist us in knowing not only what has happened or what has failed to happen in a particular case but whether the cause is still active.

Improvement in our appreciation of the confines of the normal, the limits beyond which untoward changes take place, will aid us in deciding *what* to treat. The study of the growth process of the patient will furnish added means of forming judgment on *when* to treat, and these elements with appraisement of function will materially improve our ability to forecast the results of treatment.

There is no intention in this presentation of depreciating the importance of appliance technique, which is an instrument through which results may be attained. A consideration of the systemic condition of the patient is offered as assistance in attaining a more effective and enduring application of the mechanics of tooth movement.

The case reports which follow were selected to illustrate certain of the suggestions previously mentioned. They should be considered in the light of the questions which they raise, not as final answers to these questions. They are offered to stimulate thought in this direction to the end that more comprehensive data may be accumulated and more concrete principles developed.

CASE REPORTS*

CASE 1.—S. O. is an unfortunate girl with congenital and postnatal deformities. She was first observed at seven years nine months when physical examination revealed her to be both under average weight and below average height for her age. There was fusion of the terminal phalanges of both thumbs and great toes and fusion of three thoracic vertebrae. Her mental development was somewhat, though not greatly, retarded, notwithstanding a premature closure of the cranial sutures which limited normal growth of the cranium and was evidenced by definite digital markings of these bones. The maxilla was rudimentary, giving the appearance of exophthalmos and marked prognathism, as the mandible approximated normal size. All tooth units were present. The permanent tooth crypts and the roots of the deciduous teeth were crowded in the maxillary alveolar process which, due to the markedly restricted maxillary base, gave the impression of cleft palate while no perforation existed.

*Ten case reports were included in the original presentation, of which, due to the limited space available, only two are given here.

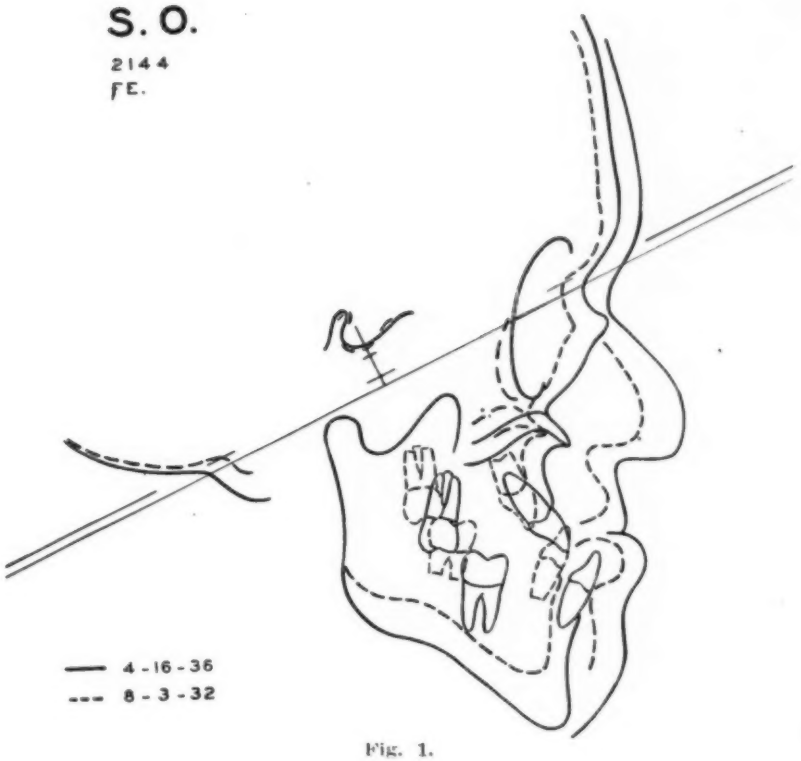

Fig. 1.

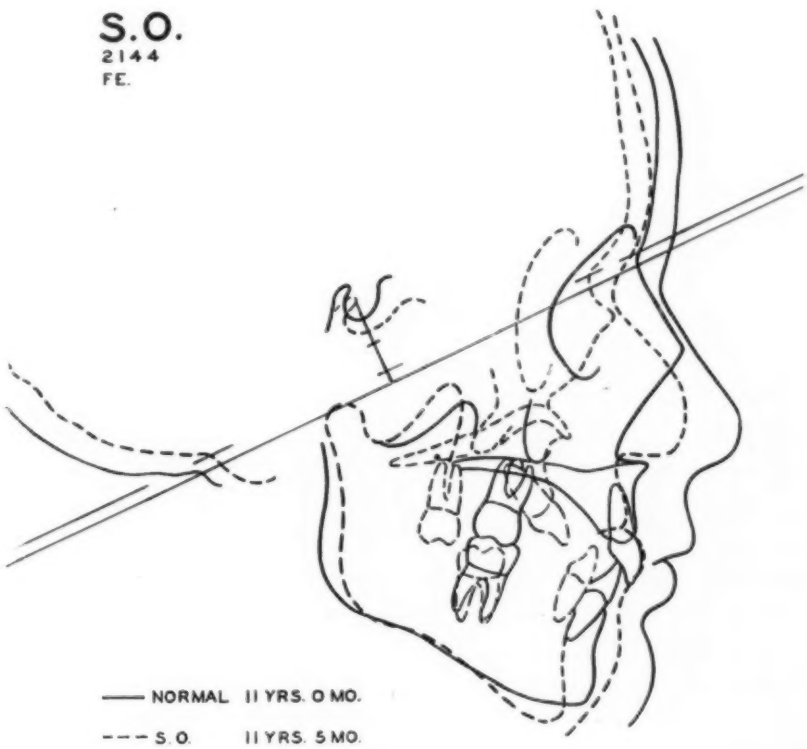

Fig. 2.

Fig. 1 represents line tracings of profile cephalometric x-ray pictures prepared through the kindness of Dr. B. H. Broadbent. The child at seven years ten months is represented by the dotted line and at eleven years five months by the solid line. In this interval she received surgical attention, including bilateral decompression operation for the relieving of intracranial pressure and orthopedic surgical operation of both thumbs. In addition there were two periods of orthodontic treatment, one of twelve months resulting in an increase of lateral width of 10 mm. and one of fourteen months in which there was a gain in width of 8 mm. It will be noted that the increase in

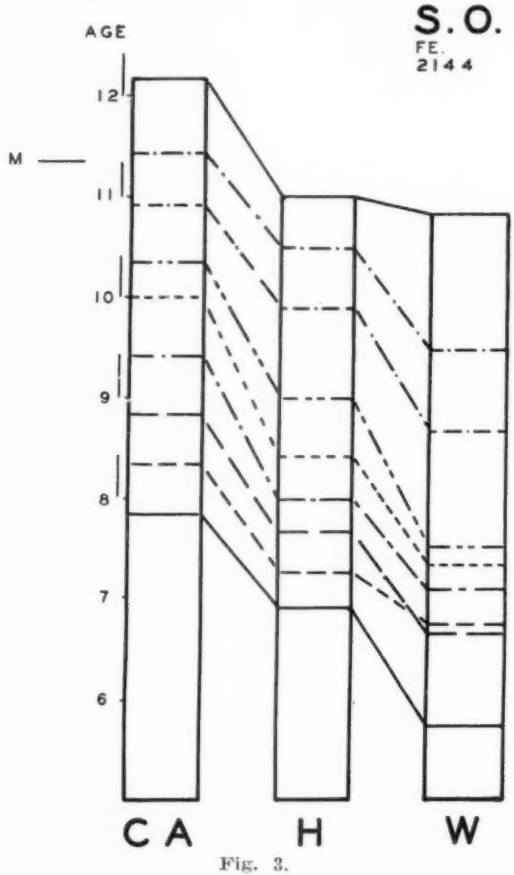

Fig. 3.

maxillary dimension in the sagittal plane was equal to the gain in the mandible. Whether a more rapid rate of growth in the maxilla, which very obviously had not maintained proportionate increase in dimension, was due to mechanical stimulation or whether the deterring factors no longer operated is difficult to determine. It is significant that (a) the maxillary denture and maxilla increased in at least equal proportion to the mandible anteroposteriorly and more rapidly than the mandible laterally under treatment and (b) the maxilla and alveolar process did not materially exceed the growth in the mandible.

Fig. 2 shows the superimposition of a normal child of eleven years no months upon the tracing from the patient's x-ray picture at the age of seven

years five months, which was the solid line in Fig. 1 (furnished by the Bolton Foundation, Department of Anatomy, Western Reserve University). It will be observed that the mandible approximates the typical; yet there are differences characteristic of the Class III function demanded by the deformity. The very great retardation in maxillary growth is apparent.

Fig. 3 is a chart based upon the data of the Brush Foundation, Department of Anatomy, Western Reserve University (typical growth figures computed in 1936 for children of that study). The column CA represents chronologic age, H height, and W weight; M to the left of the chronologic age column designates the onset of menarche. The lines across these columns represent the gain made by the patient in the respective categories and computed in months. It will be noted that the child was retarded in height and weight

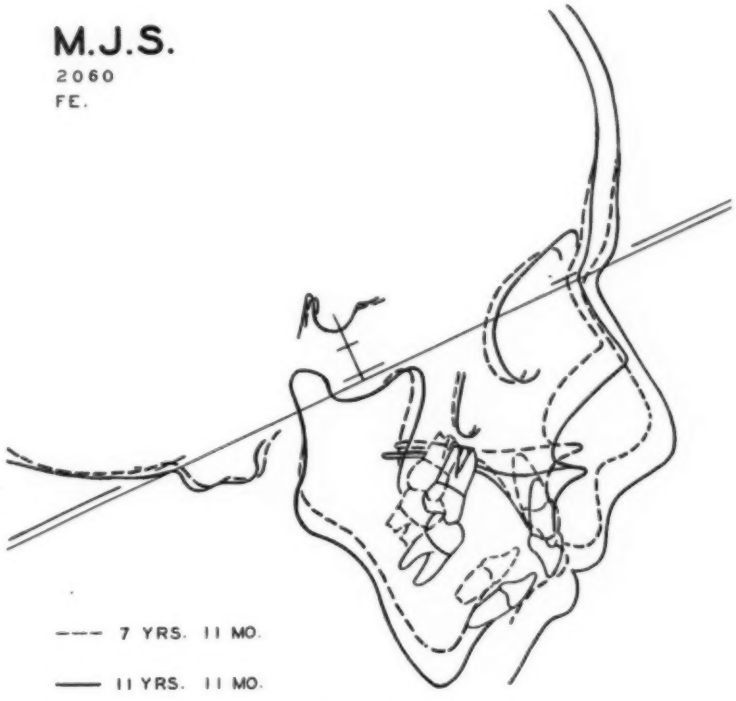

Fig. 4.

gains until ten years four months, at which time, perhaps due to the growth spurt which frequently precedes and accompanies the onset of menstruation, the height and weight exceed the chronologic interval. Later at twelve years two months height gains taper off but weight makes a proportional increase. This is a characteristic observation at the time of adolescence.

Case 2.—M. J. S. is a girl who was also below average height and weight but suffered no congenital deformities. She was subject to allergic manifestations, which were the only marked general systemic features of her history. The patient was first observed at six years ten months, and in the following six years received three short periods of orthodontic treatment.

Fig. 4 represents line tracings prepared by the courtesy of Dr. B. Holly Broadbent of lateral cephalometric x-ray pictures at age seven years eleven

months (dotted line) and eleven years eleven months (solid line). The lack of both maxillary and mandibular development is apparent. Deficient height in the ramus is a notable feature. It is interesting that mechanical stimulation had very little if any effect upon the form of the bone, although tooth position as shown in the casts (illustrated in the original presentation only) was materially improved. It is probable that indifferent function, always a serious factor in this case, may be a related feature.

Fig. 5 shows tracings from the same source in which an average eleven year no months profile (from the Bolton Series) is superimposed upon that of

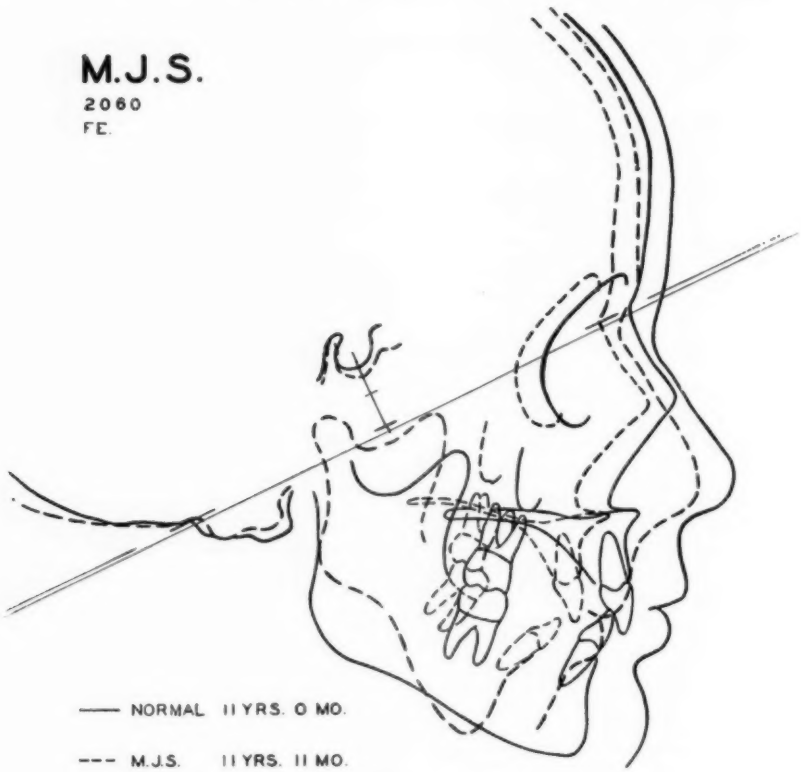

Fig. 5.

the patient at eleven years eleven months. Notwithstanding approximately one year's difference in age, the atypical facial form and development of this child are apparent.

Fig. 6 supplies the growth chart. As in Fig. 3, CA represents chronologic age, H height, and W weight. The linear divisions indicate time intervals between examination on the column CA and the monthly increase in height and weight as computed from the statistics based on regular interval observation of typical privileged children of Cleveland made by the Brush Foundation and compiled in 1936. The material improvement noted after nine years eleven months might be attributed to preadolescent growth impulse, but menarche had not been experienced up to twelve years two months, and it is more likely that sending the child to Arizona for the dura-

tion of the school year and to northern Michigan in the summer had a direct bearing on her allergy, which improvement was reflected in her growth. It is also not unreasonable to suppose that the result of treatment following twelve years will be more gratifying as recent clinical observation suggests, though examination at a later date will be needed before final judgment may be passed. It is safe to say, however, that complete potentiality of facial development will never be attained.

CONCLUSION

1. Accurate diagnosis and skillful mechanics do not completely solve the orthodontist's problems.

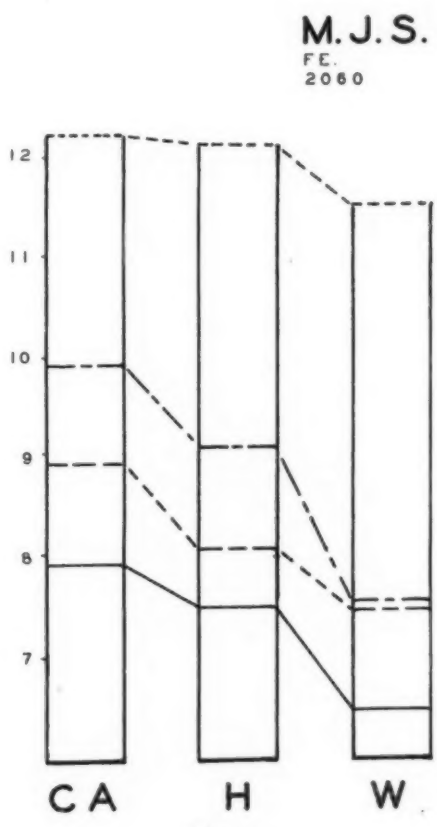

Fig. 6.

2. The face is one of the most sensitive areas of the human body to systemic disturbance.

3. Because of the delicate balance required between growth, development and function, subclinical disturbances may be most evident through their effect on facial development.

4. Facial deformities and malocclusion may often be the means of discovering general systemic disturbances, but it should be remembered that these local conditions seldom name the exact cause. They indicate a deviation from normal progress; its etiology must be sought elsewhere.

5. A knowledge of the systemic background of the child and appraisement of his general as well as facial growth and developmental progress will be found to be of assistance in diagnosis, treatment and prognosis.

The author is indebted to Dr. B. Holly Broadbent for preparation of profile x-ray tracings from roentgenograms made with the Broadbent-Bolton Cephalometer by Dr. Allan G. Brodie at the Department of Graduate Orthodontia, College of Dentistry, University of Illinois; to the Bolton Foundation, Department of Anatomy, Western Reserve University, for typical age tracings selected by Dr. Broadbent, taking into consideration the physical characteristics of the child; and to Dr. T. Wingate Todd and the Brush Foundation, Department of Anatomy, Western Reserve University, for usual monthly gains of healthy children in height and weight as compiled in 1936.

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THE CHEMISTRY, MECHANICS AND METALLURGY OF PRECIOUS METALS USED IN ORTHODONTIA

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IN A paper devoted to recent chemical and metallurgical improvements directly related to the practice of orthodontia, it will be necessary to divide the subject somewhat, also to enter into some theoretical considerations.

Pure metals find very little application in orthodontia, or, for that matter, in industry; therefore the subject deals primarily with alloys, the latter obviously possessing the required strengths. Invariably the metals used in orthodontia have their origin from the melted state. In some few instances, they might be cast directly into definite shapes and usable articles, but the great majority must be forged or rolled at low temperatures, a procedure known as cold working.

In the making of a cast ingot, which will subsequently be forged or shaped, the pouring temperature and the rate of cooling play important parts, as also does the mass being cast and the shape and composition of the mold. By a skillful control of these conditions, it is possible to adapt a suitable material to meet specific requirements.

In the preparation of the cast ingot the great influence of the electric furnace cannot be disregarded. In the fabricating from the cast ingot, the electric furnace, with its accurately controlled temperatures, again comes into use. In the final annealing, under controlled temperatures and even atmospheres, the electric furnace is also invariably used. The following important elements have become available only after development of proper electric furnace technique—aluminum, copper, magnesium, titanium, manganese, tungsten, beryllium and tantalum. These elements enter into a great multitude of products ranging from aircraft parts to vacuum tube filaments.

The fundamental problem in the creation of structures, including those in orthodontia, is the shaping and joining of the parts. In this respect, the electric furnace has contributed invaluably during the past few years. Two of its products are of particular note in orthodontia, namely, tantalum and tungsten carbides. These exceedingly hard alloys are used as cutting tools and drawing dies, to form the parts essential in orthodontic construction. If softer materials were used, the wear would be rapid and there would be no interchangeability of parts. These points will be particularly shown in a few of the illustrations which follow. The latest major advance in the electric furnace practice for melting metals, dating from its inception in 1800 by Sir Humphrey Davy, has been made by Edwin F. Northrup of Princeton, with his high frequency induction electric furnace. This equipment has been mentioned in previous papers; however its value has increased with added knowledge and experience.

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Delivered before the American Society of Orthodontists, Thirty-Fifth Annual Meeting, Chicago, April 22, 1937.

In spite of constant repetition, it is usually quite difficult for any one not conversant with electrometallurgy to grasp the idea of melting metals with induced electric currents. A description of this method for melting metals would be a paper or series of papers in itself; consequently it can only be mentioned by virtue of what it can accomplish. It can melt the complex gold-platinum alloys used in orthodontia in a fraction of the time required by a gas or flame furnace. It can melt platinum-iridium alloys quite easily, which of course is an impossibility in any flame type of furnace other than the oxy-hydrogen flame. It not only melts the metals but stirs them vigorously, thus assuring the all important homogeneity. It can melt in the absence of air, in vacuo or under any atmosphere. It is the finest research equipment ever placed in the hands of a metallurgist of precious metals.

Except for the constant research which must be carried out through the advent of new elements recently obtainable in commercial quantities such as indium, beryllium, etc., further improvement in orthodontic materials is rapidly becoming a function of the mechanical engineer or designer, the tool and the die maker.

Of the new elements employed in dental metallurgy, one which has proved of value is indium. This hitherto little known and exceedingly expensive element is now available in commercial quantities at a price slightly lower than platinum. It is element Number 49 in the Periodic Table and was discovered in 1863 by two German chemists, Reich and Richter. It was called indium because of the indigo lines in the spectrum. The process for recovery, however, from residues, was complicated and expensive, and only recently through the efforts of W. S. Murray and Daniel Gray has indium been available in quantities sufficient for commercial consumption. Indium possesses peculiar properties which justified an intensive research into the possibilities for its use in dentistry. It is a white, lustrous metal, soft and ductile and slightly heavier than zinc. It melts at the extremely low temperature of 311° F. but does not boil until it reaches approximately 2642° F. Due to the fact that it is immune to oxidation and discoloration at ordinary temperatures, and is completely miscible with the majority of elements or alloys used in dentistry, this research presented interesting possibilities.

In an effort to improve the physical properties and casting ease of various alloys, research was carried out with a number of elements which might "degas," cleanse or otherwise improve the solidity and soundness of the finished casting. Among these elements were boron, silicon, titanium, phosphorus and others. Nothing, however, was found which would improve castings more effectively than the generally used small amount of zinc. While zinc promoted soundness or lack of voids and inclusions, it also promoted brittleness and a condition of extreme weakness at elevated temperatures. While it melts at 786.9° F., it also boils at 1706° F. Only after research, repeated many times and verified, could it be shown whether or not indium, in addition to promoting casting ease, would also promote soundness in the cast ingot, and improve other desirable physical properties.

Following accepted standard methods of testing on proper equipment and over a series of several hundreds of tests, the following average improvement was effected on certain alloys—14 per cent increase in ultimate tensile strength

and 24 per cent increase in ductility as measured by percentage of elongation. These particular figures were based on air-cooled specimens, but improvement was also shown on quenched and oven-cooled specimens. The addition of indium showed such decided and desirable improvement in physical properties that its adoption was decided upon. The dental field can derive satisfaction in the thought that a little known element has come into general use in dentistry before its desirable properties have become fully recognized and adopted in large industrial applications. It undoubtedly will find many uses in other fields, and unlike platinum group metals, increasing demand will decrease the cost of production.

Beryllium, an element previously unknown to dentistry, also offers some interesting possibilities. It is steel gray in color and will not oxidize appreciably at ordinary temperatures. Its specific gravity is approximately 1.8. It is extremely light as shown by the specific gravity of aluminum, which is 2.56. One of its outstanding properties is its great affinity for oxygen, nitrogen, sulphur and carbon, elements which are decidedly injurious to gold-platinum alloys. The pure metal is still difficult to obtain in commercial quantities, but it can be obtained alloyed with copper. The small percentage of impurities, however, in this alloy makes reliable research quite difficult. Five per cent of beryllium added to pure gold produces an alloy with a hardness of over 400 Brinell and tensile strengths comparable with orthodontic wires. A number of difficulties, however, are encountered in the melting and pouring of these alloys, and specialized equipment is necessary. Its melting point is 2360° F. More will most probably be heard of this element in the near future.

Before showing photomicrographs illustrating recent developments or improvements in the metallurgy of precious metals, it might be well to describe briefly the preparation, also interpretation of the various specimens. The specimen selected must first be ground to obtain a flat surface, then further ground with finer emery paper, and finally finished by wet polishing with extremely fine abrasive. Inasmuch as the specimens are small, they must be mounted in bakelite, vulcanized rubber or some other suitable holding media, primarily not affected by acids. If it is desired to examine the specimen for inclusions, blowholes and similar imperfections, they are merely polished, If, however, it is desired to bring out the crystalline structure, the surface is etched by means of various reagents, usually aqua regia. Through etching, among other things, uniformity or homogeneity may be determined. Slight etching outlines the polygonal boundaries of adjacent crystalline grains or groups. Deeper etching imparts different colorations to the various contiguous grains, due to the similarity of orientation in any individual grain, but a change of orientation when passing from one grain to another. According to Ewing, grain boundaries are made evident by the differential action of the acid or etching reagent producing differences of level, by attacking one grain more energetically than another. Each of the short sloping surfaces, connecting one grain with another, will appear black under vertical illumination, because it does not reflect light back into the tube of the microscope.

Some of the following illustrations will help to clarify the interpretation of photomicrographs.

Although a great deal has been written on high frequency inductive melting, the principle is still probably not thoroughly understood. Fig. 1 serves to demonstrate the extreme flexibility of this equipment. It shows a quartz tube containing metal to be melted, held over the inductor coil of a high frequency converter. Current of commercial frequency is converted into current at high frequencies, which in turn is induced through the nonconducting quartz container into the metal to be melted. The inductor coil is at room temperature or colder due to its construction of copper tubing through which water circulates. The container may be held in the hand with comfort because of the speed at which the metal melts. The container is connected to a vacuum pump and the molten metal is degassed and solidifies under vacuum. Science knows of no better method for producing sound metal.

Fig. 1.—Inductive melting under vacuo.

It might be of interest to note that this is the identical method used to degas the grids in radio tubes and shares its part in the fine reception possible with modern sets. The metal within the radio tube is heated to a point above that which it will reach in service; gases are driven off and evacuated by means of a vacuum pump; and the tube is then sealed. By preserving the vacuum which would otherwise be affected by gases from the heated grid and filament, the efficiency is increased and the life lengthened. It would be difficult to conceive how this operation could be accomplished without inductive heating.

The view of platinum segregation shown in Fig. 2 has been etched with aqua regia, plus chromic acid, as are all of the following etched views. It shows some platinum in solution, but a great deal still incompletely dissolved. This particular alloy had been melted once in a flame furnace. Segregation in any alloy leads to many difficulties. Figs. 3 and 4 have been shown previously, but they still illustrate best the result of nonuniformity in a casting as reflected in a finished product with which the orthodontist is most familiar.

Fig. 4 shows complete homogeneity. One part of the field is almost identical with any other part of the field. Wire of this nature would be completely dependable. Wire of the view shown in Fig. 3 would be anything but reliable. In both views it is easy to recognize cold worked structure and the direction of cold work or drawing.

After casting an ingot from a high frequency furnace, it would of course be effort and expense wasted if all annealing precautions were not exercised during drawing, rolling or swaging. The electric furnace (Fig. 5) has automatic time and temperature control and the metals are annealed under hydrogen

Fig. 2.

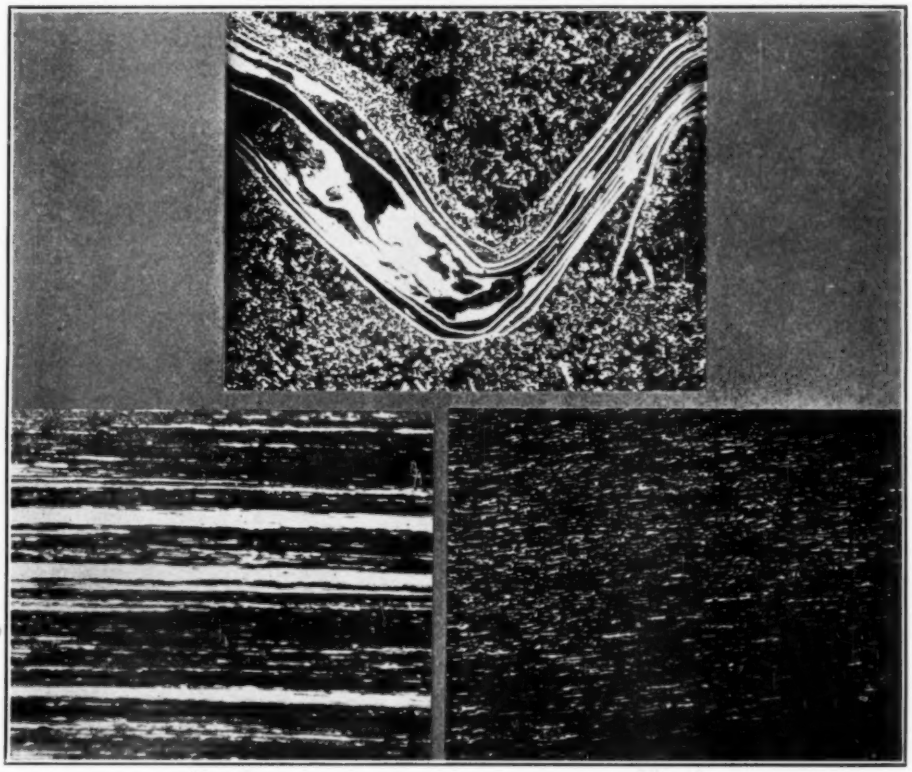

Fig. 3. Fig. 4.

Fig. 2.—Segregation in a complex high platinum content gold alloy (×50 etched).
Fig. 3.—Gold-platinum complex alloy wire showing decided segregation (×125 etched).
Fig. 4.—Gold-platinum complex alloy wire showing uniform structure (×125 etched).

gas. There can be no contamination or oxidation. Since there can be no oxide film, pickling is not necessary. Bars or rods may be quickly chilled or slowly cooled with no exposure to the air.

The unetched view in Fig. 6 shows oxides, slag inclusions and blow-holes, the latter caused probably by trapped gases. Some of the voids are also undoubtedly caused by localized shrinkage. None of the following photomicrographs or photomacrographs have been retouched.

The unetched view in Fig. 7 shows great superiority over the previous specimen. The imperfections are much fewer and exceedingly small.

The unetched view in Fig. 8 does not explain the additional superiority which might be expected through the addition of indium. Repeated physical tests showed the indium content alloy to possess 14 per cent greater strength and 24 per cent greater ductility. An etched view or an examination of the crystalline structure will, however, explain the reason for superiority.

This etched view very plainly shows the large crystalline groups or grains, which themselves are made up of a great number of small crystals. When metals solidify or crystallization starts, it does so simultaneously at a great many different centers. From each of these centers, a crystal grows through successive additions of crystalline matter, all similarly oriented. The grain boundaries which are seen quite plainly, mark the regions where adjacent crystalline growths collided, with resulting distortion of their external forms. Some metallurgists are also of the opinion that amorphous metal exists at these grain

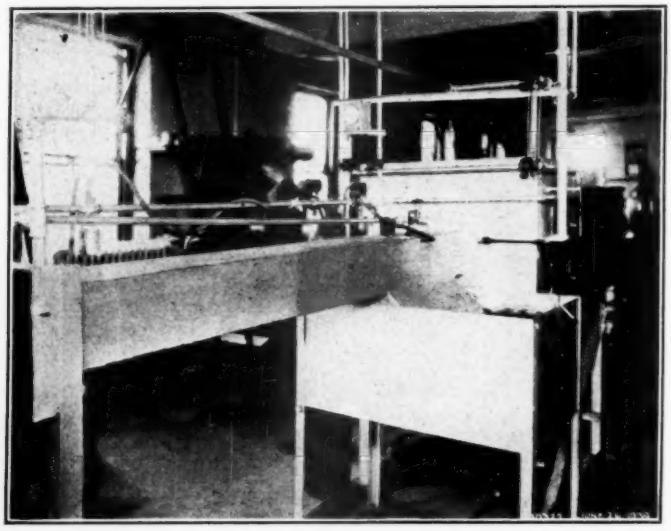

Fig. 5.—Cooling and quenching portion of hydrogen annealing furnace.

boundaries. In Fig. 9 great irregularity of the structure may be observed, also there are voids and inclusions. Between the grain boundaries, irregularity is particularly noticeable. It is to be expected that incompletely dissolved elements or impurities would be rejected to the grain boundaries. This incompleteness of solution might be expected in these high fusing gold-platinum alloys unless special precautions are exercised in this type of furnace.

The absence of the irregularity in the grain boundaries may be noted in Fig. 10; also there is greater uniformity over the entire field. There are practically no voids or inclusions, and the structure, being finer with a greater number of grain boundaries, should naturally be stronger and tougher.

The structure in Fig. 11 is greatly refined. There are fewer voids or inclusions, and there is a decided improvement in the uniformity of the structure in the grain boundaries.

The chart in Fig. 12 showing the periodic arrangement of the common elements, starting with hydrogen in the upper left hand corner with an atomic

weight of 1, down to thorium with an atomic weight of 232.5, also shows the similarity of the elements when passing from one to the next in order. There is no great change in their properties. It is of interest to note the boxed in elements, namely rhodium, iridium, palladium, platinum, silver and gold. All are adjacent and are used in dental alloys. Their immediate neighbors, nickel,

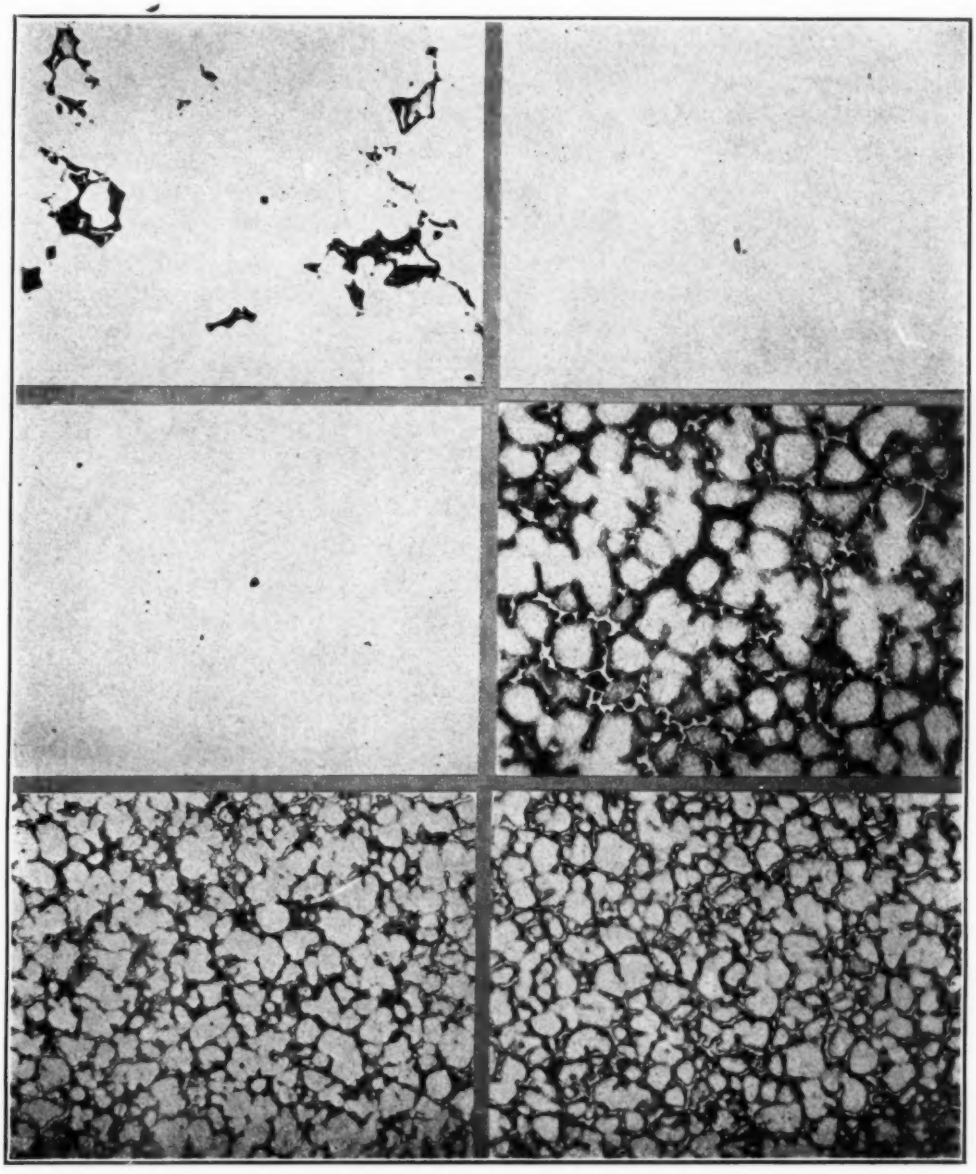

Fig. 6.—Gold-platinum complex alloy, melted in flame furnace (×200 unetched).
Fig. 7.—The same gold-platinum complex alloy melted in the high frequency induction furnace (×200 unetched).
Fig. 8.—Gold-platinum complex alloy similar to Fig. 6 and Fig. 7. Inductively melted with the addition of indium (×200 unetched).
Fig. 9.—Gold-platinum complex alloy, melted in gas furnace (×200 etched).
Fig. 10.—Same alloy as in Fig. 9 but inductively melted (×200 etched).
Fig. 11.—Same as Fig. 10 with the addition of indium (×200 etched).

copper, zinc and tin, also have their uses in dental alloys. Between tin, which is used in dental gold solders, and cadmium, which is more often employed in

jewelers' gold solders, can be found the element indium. In the making of workable alloys, it seems theoretically impossible to wander far from this grouping of similar elements. The recent copper beryllium alloys, however, tend to disprove this theory, or is possibly the exception that proves the rule.

It has been attempted so far to show improvements which may have been effected in orthodontic materials through the use of latest equipment in the metallurgic field, also through the use of elements not previously available in commercial quantities. Further improvement has also been made through mechanical design or research or through a similar advancement in other fields; namely, those that furnish the materials with which to form the various orthodontic items.

The building up of the orthodontic appliance does not call for many complicated structures and simplicity seems to be the objective. One of the greatest problems for the manufacturers of orthodontic materials has been to provide efficient attachment of the arch to the anchoring band. In this endeavor there has been received cooperation of a number of practicing orthodontists, who

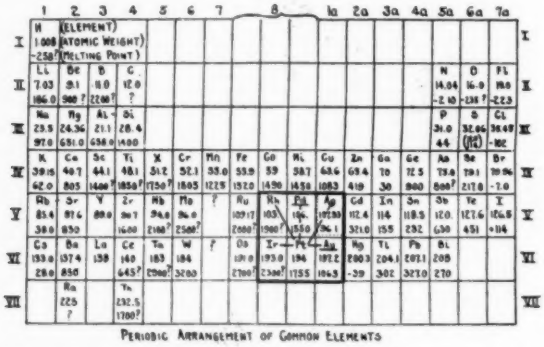

Fig. 12.—Werner rearrangement of Periodic Table, showing grouping of similar elements.

unselfishly gave a great deal of their time and effort toward a solution or possible improvement of this problem.

In the illustrations which follow, showing various methods for attachment of the arch, there are some examples where it has been impossible to trace the origin or the designer. Their past histories are probably better known to the orthodontist. In these photomacrographs of arch locks or attachments, there can be seen definite evidence of the cooperation the metallurgist continues to receive from the orthodontic profession. Although the volume of metal consumed by orthodontia is not large, the quality, precision of workmanship and ingenuity of design make for it the most interesting problem in dental metallurgy.

Fig. 13 shows probably the simplest form of attachment and one which presents greatest ease in manufacturing. It is a fairly simple matter to drill accurate holes either in metal which can be hardened, in the various newly developed carbides, or in a sapphire or a diamond. The accurate and extremely hard dies with imperceptible wear, assure true outer surfaces of the tube and post, also a hardened mandrel, over which the tube is drawn, guarantees its accurate interior. In spite of the apparent discrepancy in fit, due to the magnification of thirty diameters, the tube and post actually fit to the closest pos-

sible practical accuracy. The post is deliberately manufactured 1/1000 of an inch smaller than the inside diameter of the tube. If this play or tolerance were any less, it might be impossible to insert the post into the tube.

Fig. 14 shows another type of attachment, not however in general use. In spite of exercising the greatest precaution, this comparatively high magnification readily discloses the flaws in fabrication. For practical purposes, however, the fit is quite accurate.

In the past few years the so-called half round tube and post (Fig. 15) has been the generally accepted method for attachment of the lingual arch. The corners of the post have been rounded both for ease of insertion and for better wearing properties. A tube and post of this type is not easy to manufacture, and presents difficulties not readily appreciated. The radii of both the tube

Fig. 13.

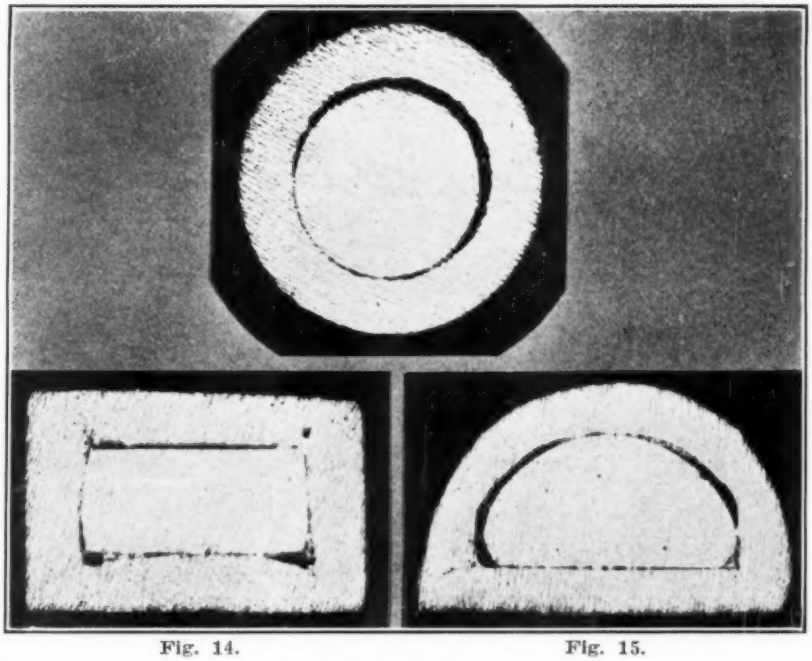

Fig. 14. Fig. 15.

Fig. 13.—Round tube and post (×30 unetched).
Fig. 14.—Rectangular tube and post (×30 unetched).
Fig. 15.—Half round tube and post (×25 unetched).

and the post must be absolutely accurate; otherwise the tubes and posts not only will not be interchangeable but also will not be reversible. The apparent misfit as shown here is a deliberate incorporation in the tube and post. The points of closest fit must be the base of the tube and post, and the point on the semicircle arrived at by erecting a line bisecting and perpendicular to the base.

Fig. 15 will serve to explain Figs. 17 and 18. The anchoring principle is that of a double pin tube and post.

The type of attachment shown in Fig. 17, designed by Paul G. Spencer, presents interesting possibilities. One possible objection might be its size, and another, the difficulty of insertion. These objections can be eliminated, however, and it might be possible to retool or redesign and bring this method of attach-

ment into more general use. The tubes are die formed from flat metal, the posts from one piece of die formed wire, bent in the shape of a U. The wire, at the point adjoining the arch, is flattened.

Fig. 18 shows the general principle of Fig. 17 with the exception that there are no seams and the size has been greatly reduced. It is also concaved lingually for better fit on the anchor band.

Fig. 19 serves to explain better the photomacrograph in Fig. 20.

The attachment in Fig. 20, designed by Walter H. Ellis, is somewhat similar to the Spencer lock, inasmuch as the post consists of a double wire. The principle is that of a large oval tube into which is inserted a looped wire, which is formed from and is an integral part of the arch. This photomacrograph shows an excellent mechanical fit, and it is known that this particular method of attachment has given excellent results in the hands of many orthodontists.

Fig. 16.

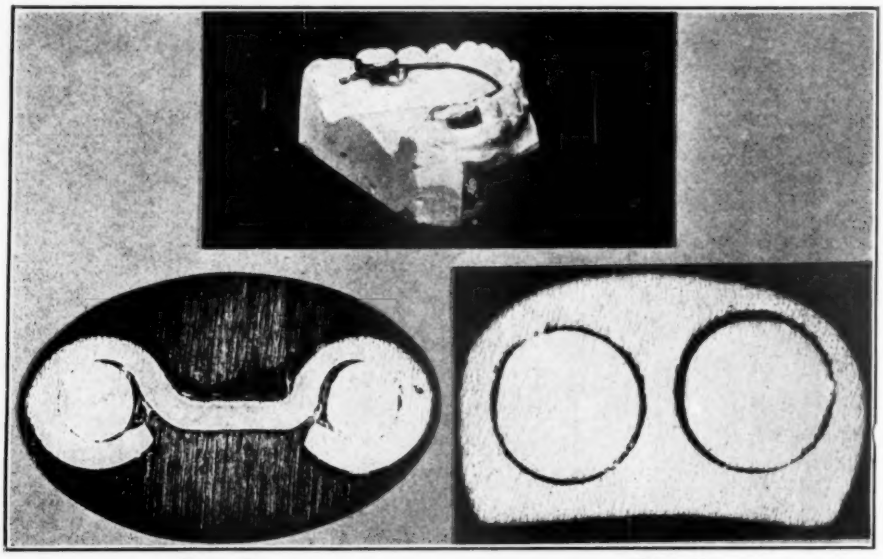

Fig. 17. Fig. 18.

Fig. 16.—Lingual arch and Spencer lock.
Fig. 17.—Spencer lock (×12 unetched).
Fig. 18.—Modified Spencer lock (×25 unetched).

The photomacrograph in Fig. 21 does not do justice to a very excellently designed tube and post. It required several years to overcome the various difficulties of this design, and it has only recently been made available to the profession. It possesses several unique features; namely, largely increased bearing surface and ability to be loosened or tightened at will. The tubes slant at one end, tapering away from the gingiva, thereby protecting the soft tissues from injury. If the tube is depressed with pliers, vertically, it can be tightened to the point where it is immovable. If depressed laterally, it is readily loosened.

Fig. 22 again shows a very unique design, namely for all practical purposes, externally, a half round tube, shaped labially, however, to conform to the shape of the band, but with an oval post and tube. Mechanically, the fit

of this oval tube and post is extremely good and possibly too close for practical purposes. This attachment is still in experimental stage and not yet available to the profession.

The tube and post shown in Fig. 23 has been the result of splendid co-operation on the part of the designer and several years of consistent effort in the endeavor to provide for close fit and absolute interchangeability. All sharp angles and wearing surfaces have been eliminated, and at the same time greater

Fig. 19.

Fig. 20.

Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.

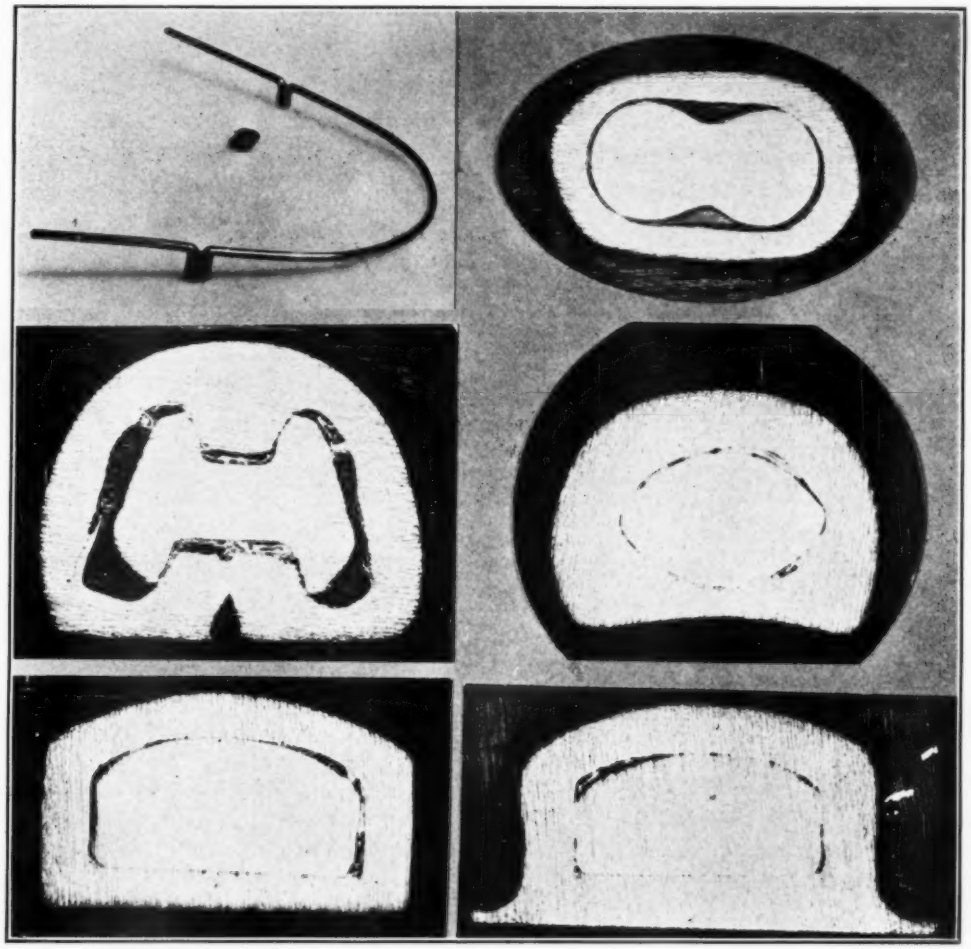

Fig. 19.—Ellis arch and tube.
Fig. 20.—Ellis attachment (×20 unetched).
Fig. 21.—Irish attachment (×25 unetched).
Fig. 22.—Oliver tube and post (×20 unetched).
Fig. 23.—Mershon tube and post (×25 unetched).
Fig. 24.—Reinforced Mershon tube and post (×25 unetched).

bearing surface has been provided. To date, this has been a universally accepted method of attachment.

This design is similar to that in Fig. 23, only the base has been extended slightly on both sides of the tube to provide for reinforcement and greater strength at the base, also for stronger attachment to the band. In spite of the apparent discrepancy in fit as shown at this magnification, a closer fit would not be practicable or acceptable.

Of all the commodities which have been affected by the depression, none have been affected more so than the precious metals. Increasing prices, a vague uncertainty as to future supply, also possibly even because of desirable physical characteristics, base metals have entered into orthodontic practice. There does not seem to be a remote possibility of gold returning to its old price; consequently metallurgists in the field of precious metals must offer to the orthodontist advantages not inherent in other metals. Gold alloys and base metals are sometimes used in combination, such as base metal construction joined with gold solder. Views of this work might be of interest.

In Fig. 25, a view of stainless steel wires united with gold solder shows several interesting points; namely, imperfections or voids in the gold solder, also the nonpenetration of the solder into the steel. There also seems to be a serious lack of contact at all borders of the joint. This, however, is misleading inasmuch as the dark streaks between the solder and the wires are due to shadows caused by the difference in level produced by polishing the two metals.

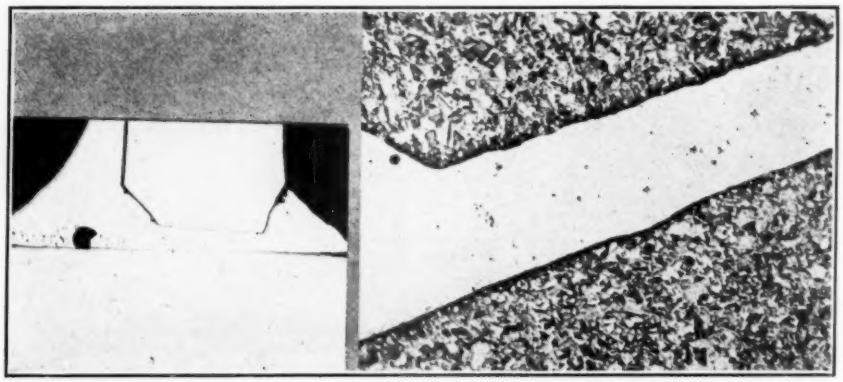

Fig. 25. Fig. 26.

Fig. 25.—Stainless steel wires with gold soldered joint (×40 unetched).
Fig. 26.—Stainless steel wire and gold solder (×200 etched).

The gold solder is obviously softer. If this specimen had not been examined under the microscope, before being highly polished, misleading conclusions might have been drawn.

In Fig. 26 it can be observed that the etching reagent attacked the steel deeply but affected the gold solder only to the extent of showing the usual pits or imperfections at the line of contact of gold solder and steel. The structure of the latter is totally obscured, due either to extremely deep acid attack, or to a difference in level as shown in Fig. 25.

Complaints from orthodontists continue to be very much the same although undoubtedly are fewer in number. Manufacturers have well-established testing laboratories, and defective materials seldom get by rigid inspection. A prolific source of trouble, however, is due to varying demands among the orthodontists. A single product, such as a spring wire or a banding material, may be identical in formula, yet vary widely in physical characteristics, due to the degree of heat employed in annealing or to the amount of cold work, such as drawing or rolling, after annealing. Some orthodontists demand that some "cold work"

hardness be left in their materials, in spite of the fact that application of heat, such as soldering, will alter the hardness at that point. The orthodontists who so order, place themselves at the disadvantage of seldom receiving materials of identical physical characteristics, inasmuch as they are not in a position to request determined degrees of hardness or other measurable properties. Closely fitting tubes and posts demanded by some will not be accepted by others and in which event painstaking and expensive die construction is a loss. With the great variation in techniques and demands, there is consequent confusion on the part of the producers. This will undoubtedly be lessened if there comes about a tendency toward standardization in technique and practice. This standardization is already well under way in the casting practice of the general practitioner, with resulting fewer casting failures.

A common complaint continues to be breakage of arch wires. Disregarding defective materials, caramels, rock-candy, poor eyesight, and the human element in general, breakage may be decreased by proper knowledge and performance of heat treatment. Breakage is usually caused by a hardening of the wire at the point of failure, to a condition of brittleness. This hardening may be caused by two factors; namely, cold working by the patient or the orthodontist or hardening heat treatment imparted to the wire during a soldering operation. Prolonged heating, followed by slow cooling, increases tensile strength as measured by tension tests, but orthodontic stresses do not produce tension strains, but on the contrary are transverse applications of force. Conditions which increase tensile strengths of metals invariably decrease ductility, making them especially vulnerable to breakage under transverse stresses. Hardness of the wire, imparted under any of the foregoing conditions, may be quite easily removed by simple heat treatment.

The wire or finished appliance is merely heated to a dull red temperature and quenched immediately. In relieving these strains in a finished appliance, naturally the annealing temperature should be well below the melting point of solder. This procedure, if skillfully carried out, would probably be good practice every time an appliance is removed from the mouth. It would most certainly eliminate lots of breakage, especially at that very vulnerable point adjacent and anterior to the anchor band. The great majority of orthodontic wires possess ample springiness even in their softest annealed condition.

Soldered joints continue to break, not only because of excessive and prolonged heating, but also because of improper fluxes. Soundest and strongest joints are accomplished using the minimum of heat necessary to flow the solder. Excessive heat will ruin gold solder as it will most other alloys. The damage might also extend to the adjoining portion of the appliance. When solder flows, it is good practice to remove from the flame immediately. A secondary heating or soaking is usually harmful.

Some soldering fluxes in so-called paste form are composed essentially of vaseline and borax. If the jar container is kept in a very warm place and over a considerable period of time, the mix is only mechanical and the greater part of the borax will find its way to the bottom of the jar. Fluxing for the most part with vaseline will produce improperly soldered joints.

Manufacturing jewelers, who do extremely fine soldering on very difficult materials, invariably use fresh solutions or paste, composed entirely of borax or boracid acid and water.

Banding materials still come in for varied criticisms, due sometimes to varied demands and varied techniques. It seems obvious that they should be high fusing if for no other reason than the fact that every one makes mistakes. It is rather discouraging, however, for an operator to move a soldered tube a little to the left and find a hole where the unsoldered tube used to be. High fusing points, however, call for platinum group metals with necessarily higher costs. If more inexpensive materials are demanded, it must be at a sacrifice of quality. If precious metals command a price, they also command admiration. They are used in the arts and industry to fulfill demands in which absolute reliability is required. By a lessening of the precious metal content of an alloy, seldom, if ever, can similar properties be reproduced.

Due to rapidly rising prices, hurried research has been carried out to provide more inexpensive substitutes for the usual gold-platinum alloys. These substitutes were, for the most part, high content silver and palladium alloys, and were to some measure successful. Many of them, however, possessed the disappointing property of tarnishing in the mouth, which is characteristic of any high silver content alloy, especially under the conditions they encounter. Both metals are soluble in single acids and their inclusion in large percentages is subject to question. Appliances constructed from these alloys can easily be dissolved or at least reduced to a framework of silver chloride.

In closing, any progress which has been accomplished with precious metals in the orthodontic field has been invariably with the assistance and cooperation of practicing orthodontists who understand their own problems. It is with this cooperation that progress will continue.

TREATMENT OF A CLASS I (ANGLE) MALOCCLUSION

HOWARD J. BUCHNER, D.D.S., M.S.D., OAK PARK, ILL.

HISTORY.—The patient, a girl, aged thirteen years and eleven months, presented for treatment in January, 1934. The father and mother have some lack of development of the dental arches. The child's birth was normal. She was fed artificially in infancy. The tonsils and adenoids were removed at four years and six months; for the most part, respiration has been normal. She had measles at four, chickenpox at five, and whooping cough at eight years of age. The patient bites the finger nails very extensively. She also bites the lower lip to some degree.

Etiology.—It was impossible to obtain a complete case history regarding the time when the deciduous teeth were lost. However, a careful examination of the models would lead one to the conclusion that this malocclusion has been caused by premature loss of some of the buccal deciduous teeth, accompanied by a lack of normal growth and development. The biting of the nails and the lower lip have undoubtedly been a potent factor in disturbing the incisor relationship and tipping the mesial of the maxillary central incisor labially.

Diagnosis.—The teeth are all present with normal root formation and bone structure. The arches are in Class I relation; they are quite narrow, with a mesial drift and rotations of the teeth in each buccal segment. A study of the profile would indicate some lack of development in the incisor region. Fig. 1 shows the models and Fig. 2 the x-ray pictures before treatment.

Treatment.—Bands were placed on the maxillary incisors and first permanent molars. Lingual extensions were soldered to the molar bands with the mesial end curved so as to engage the mesial surface of each first bicuspid. A twenty gauge round labial arch was ligated to the incisors with 22 gauge vertical pins soldered to the arch opposite the center of each tooth to prevent any labial tipping. As soon as possible the lateral incisors were rotated.

Expansion force was obtained by the use of coil springs against the buccal tubes. When the arch was fully expanded, the lingual extensions were removed and bands placed on the bicuspids to rotate them into position.

Development was obtained at the same time in the mandibular arch by bands on the first permanent molars, and lingual extensions contacting the bicuspids. A twenty gauge labial arch was ligated to the mandibular incisors and cuspids. Expansion was obtained by the use of coil springs as in the maxillary arch. The active appliances were removed June 1, 1936. Bands were placed on the maxillary lateral incisors with labial spurs against the cuspids

Case reported presented at the Thirty-Fifth Annual Meeting of the American Society of Orthodontists, Chicago, April, 1937.

Fig. 1.

Fig. 2.

Fig. 3.

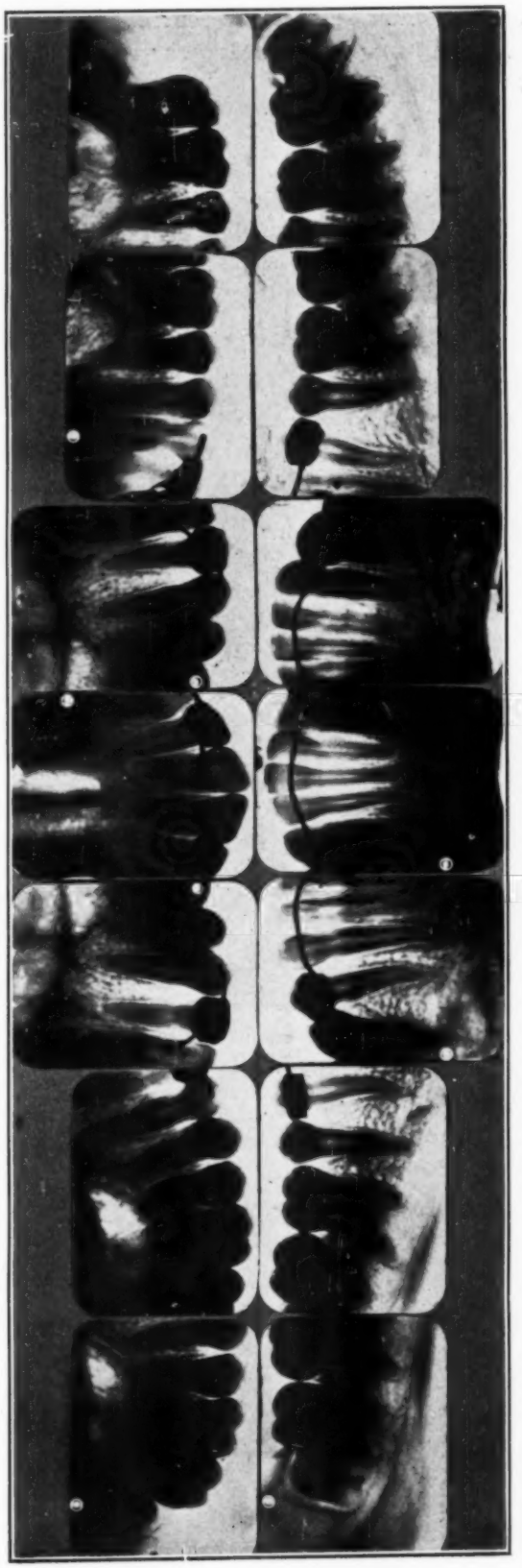

Fig. 4.

and lingual spurs against the central incisors. The mandibular first bicuspids were banded with a soldered wire resting against the anterior teeth. The retainers are still in place.

Fig. 3 shows the models, Fig. 4 the x-ray pictures, and Fig. 5 the facial photographs of the completed case.

Fig. 5.

Prognosis.—The maxillary right second molar is not completely in place yet. It is, however, erupting in a satisfactory position. The mandibular second molars are inclined slightly to the lingual, with the third molar impacted. I think it would be advisable to remove the mandibular third molars before mechanical retention is discontinued. The patient still bites the lower lip a little. If the above mentioned problems are met with, the patient should have a satisfactory functional and esthetic result.

CLASS I, OR NEUTROCLUSION, TREATED WITH NEW EDGEWISE MECHANISM

S. L. Kregarman, D.D.S., New York, N. Y.

THE case presented, although not one of unusual appearance, is a very interesting one, and it was treated by the customary routine of procedure.

It was diagnosed a Class I, or neutroclusion, case with a mesial drifting of both right and left cuspid-to-molar sections of the maxillary arch. My justification for presenting this case is that it is one of contentious classification. Judging by the models alone, a good many men would classify the case as Class II, Div. 2, and treat it as such. Study of the photographs, however, leads one to believe that the facial form is altogether harmonious and that the body of the mandible is well developed. The flattening of the central incisors is most likely due to a hypertonicity of the lip musculature.

Fig. 1.

The routine of Class II treatment would indicate a forward movement of the maxillary incisors, to be followed by mesial movement and development of the mandible. Treatment in accordance with such a plan would undoubtedly end in a toothy appearance or a protrusive upper lip. My plan, therefore, was based upon preservation of the esthetic relation, and I determined that the primary movement necessary should be a distal tipping of all maxillary posterior teeth and canines rather than a mesial movement of the mandibular posterior teeth.

Fig. 1 shows the initial models taken November, 1932.

History.—Female, aged thirteen years and eight months. Mother had been exceedingly nervous during pregnancy. The child was breast fed for three months, milk being meager and insufficient. She was bottle fed for one year.

Case report presented at the Thirty-Fifth Annual Meeting of the American Society of Orthodontists, Chicago, April, 1937.

First deciduous tooth erupted at seven months of age. First permanent tooth erupted at seven years of age. No severe illness was contracted other than children's diseases. Tonsils were removed at six years. Height 5 feet and 5 inches. Weight 125 pounds. Mentally very normal.

Fig. 2 shows photographs taken at beginning of treatment. Study of the profile photograph discloses that the body of the mandible is well formed and in normal relation to skull anatomy. Study of the upper lip would caution against any labial movement of the maxillary incisors other than necessary rotations and aligning of the arch.

Diagnosis.—Class I complicated by forward migration of buccal segments of maxillary arch.

Corrective tooth movement was indicated.

Maxillary arch:

1. Buccal movement of premolars and molars.
2. Distal movement of molars, premolars and canines.
3. Rotation of incisors.
4. General aligning to ideal arch form.

Fig. 2.

Mandibular arch:

1. Buccal movement of canines, premolars and molars.
2. Labial movement of incisors.
3. Rotation of canines and right central incisor.
4. Depression of incisors and leveling excessive dip in curve of Spee.

Manipulation of mechanism to produce these movements in maxillary arch:

1. Band all teeth except second molars and four incisors, using rectangular tubes on first molar bands and tie-brackets on others.
2. Obtain bracket engagement—using 0.022 × 0.028 inch gold platinum arch wire.
3. Place tip-back bends on buccal segments to carry teeth distally, attach intermaxillary hooks mesial to canines to use for Class II elastic force.
4. Tie in brackets, keeping anterior section away from incisors.

5. When correct axial inclination of posterior teeth is obtained, place bracket bands on four incisors.
6. Continue tip-back bends until correct mesiodistal relationship is obtained.
7. Gradually remove tip-back bends continuing wear of intermaxillary elastics, and align all teeth to ideal arch form.

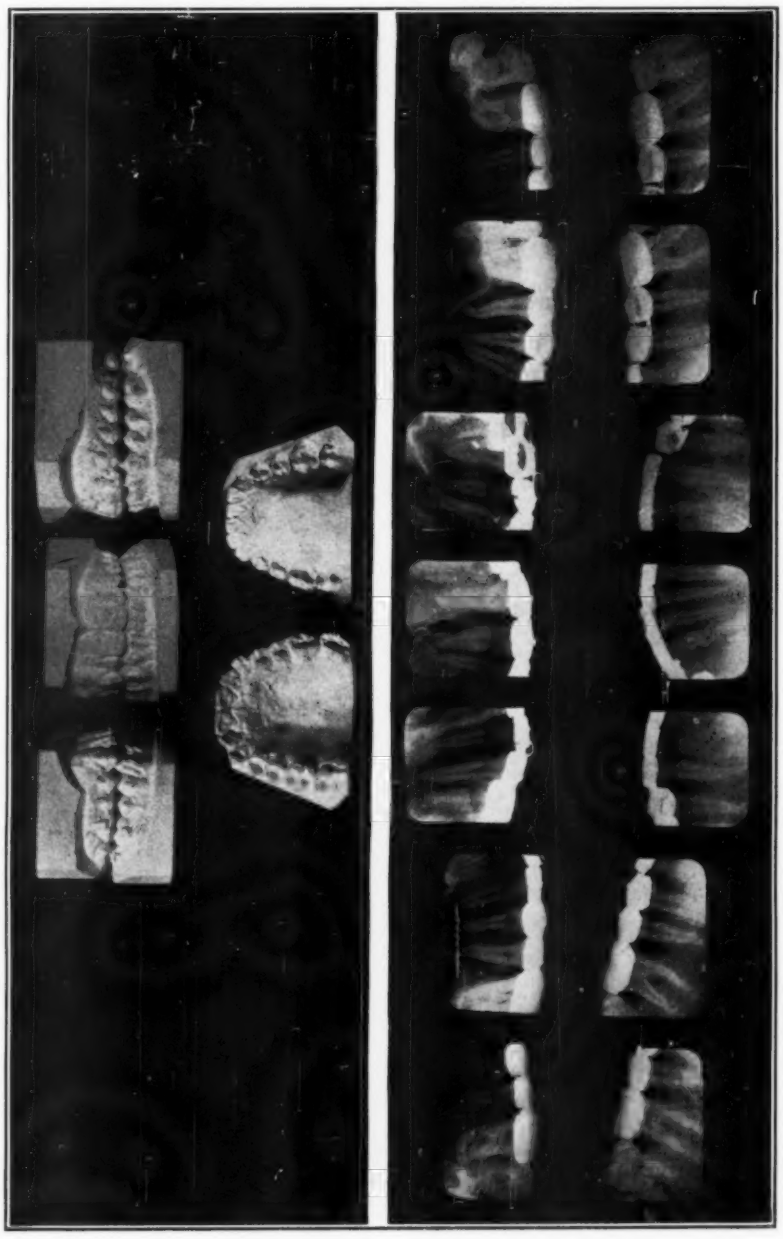

Fig. 3.

Fig. 4.

Manipulation of mechanism to produce these movements in the mandibular arch:

1. Band all teeth from first molar to first molar, with rectangular tubes on molar bands and tie-brackets on others.

2. Use round 0.020 inch stainless steel, then round 0.022 inch used until bracket engagement is obtained without warping arch wire.
3. Replace with edgewise 0.022 × 0.028 inch gold platinum wire, shaped to ideal typal arch form.
4. Place slight tip-back bends in buccal segments to insure stationary anchorage.
5. Complete rotations and the force application until ideal form of arch is obtained.

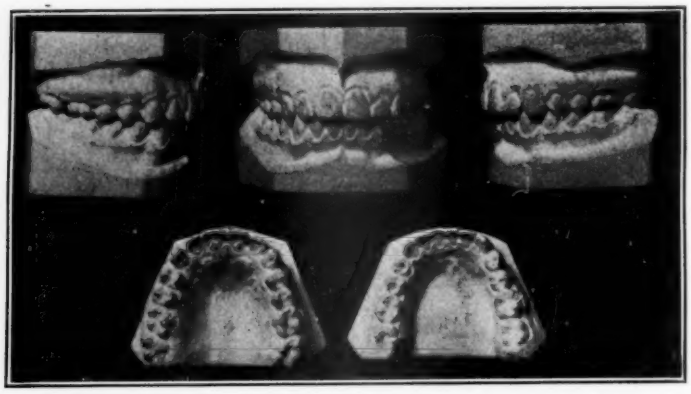

Fig. 5.

Fig. 6.

Home Treatment.—Orbicularis-oris muscle relaxing exercises to aid in lip tonicity.

Fig. 3 illustrates the case in November, 1933, when maxillary incisor bands were placed. It will be noted that considerable buccal torque had been obtained in both right and left maxillary segments. I show this to illustrate that, in struggling with a new technique, we often do things we do not desire.

Fig. 4 shows radiographs made at that time. None had been made at the beginning.

Fig. 5 shows the case in April, 1935. Retention appliances were then constructed. Fig. 6 shows photographs at this time. Treatment ended. Fig. 7 shows radiographs at this time.

Retention.—Mandibular arch, lingual bar from molar to molar and first premolar bands with lingual hooks overlapping bar.

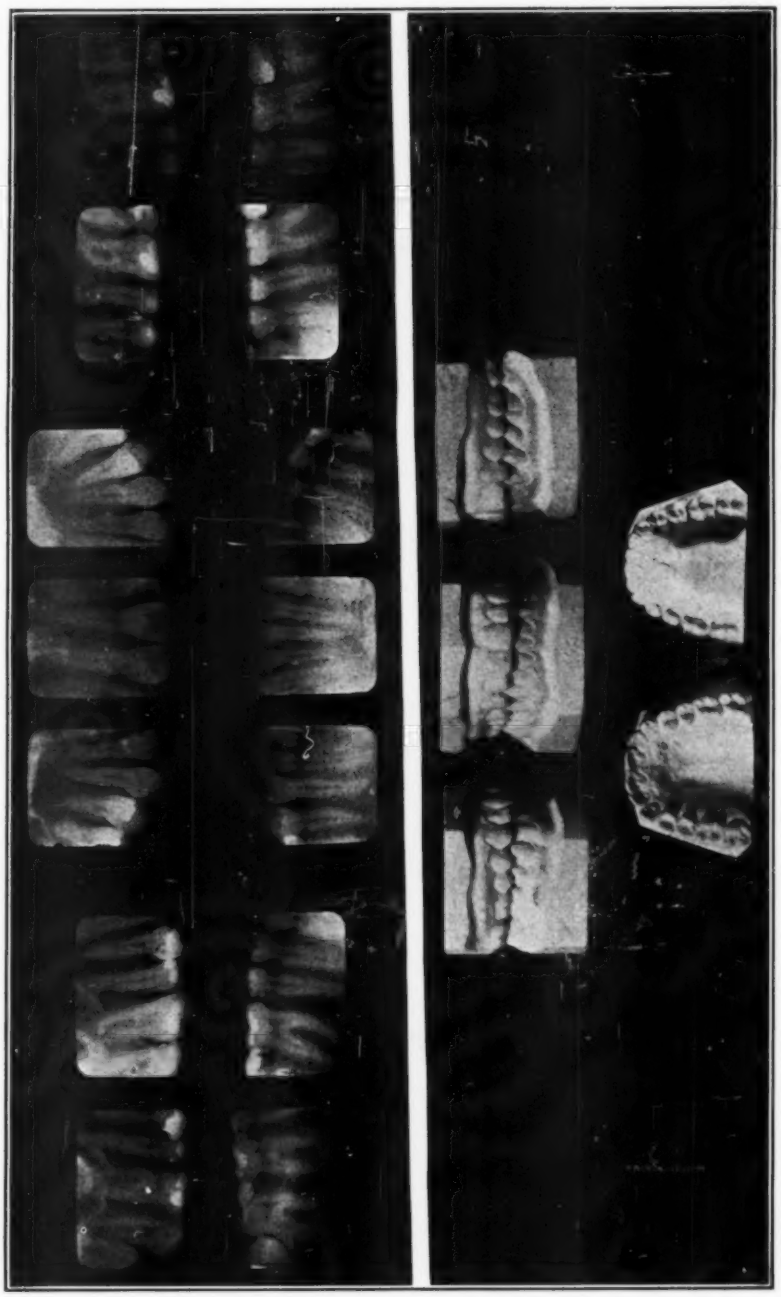

Fig. 7.

Fig. 8.

Maxillary arch, lingual bar from molar to molar with finger attachment extended at mesial to cuspid; also labial round arch from molar to molar with intermaxillary hooks in cuspid region for use of elastics at night.

Retainers were removed in April, 1936.

Fig. 8 shows models of case in March, 1937, eleven months after retainers were removed.

SIMPLE AND INEXPENSIVE METHOD OF MAKING PHOTOGRAPHIC RECORDS FOR ORTHODONTIC CASES

GUY B. FAIRCHILD, D.D.S., DULUTH, MINN.

FOR this work you can no doubt use the camera you have, by purchasing a portrait attachment suited to your equipment. Study the scale inside the cover on the box in which the attachment comes. The illustrations shown here

Fig. 1. Fig. 2. Fig. 3.

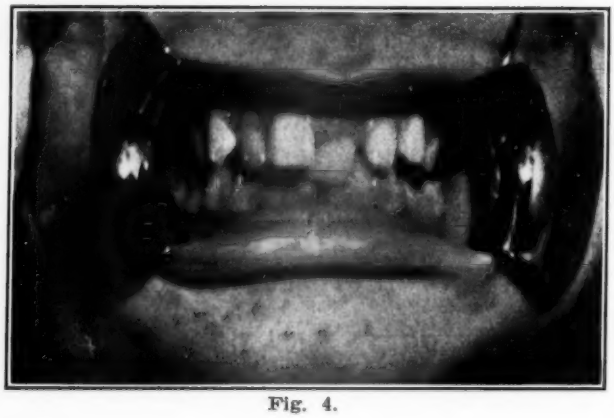

Fig. 4.

were taken with an old style, postcard Eastman Kodak No. 3A, with a 7.8 Eastman anastigmat lens, using a panchromatic film, and one No. 1 floodlight in a

Table clinic presented at the Thirty-Fifth Annual Meeting of the American Society of Orthodontists, Chicago, April 20, 1937.

reflector held behind and to one side of the kodak. The kodak was set on time exposure and aperture opening 32. The light was on for two to four seconds.

With the equipment used, the portrait attachment called for 30 inches from the lens to the eye for the front view (Fig. 1), and 30 inches from lens to tip of nose for the profile view (Fig. 2). The kodak was on a rack setting of 6 feet. For Fig. 3 the assistant stood behind the patient, facing the kodak, and by using cheek retractors exposed the teeth in occlusion. The head was held upright. Measurement should be 30 inches from eyes to lens. A yardstick can be used for convenience.

The close-up effect of the teeth shown in Fig. 4 was made by enlarging the mouth area shown in Fig. 3, four times.

The whole cost was about three dollars, not including the cost of the camera. Some trouble and experimental expense could have been saved by going to a reliable man in a camera shop in the first place.

Medical Arts Bldg.

Department of Oral Surgery

Edited by

STERLING V. MEAD AND KURT H. THOMA

Articles on oral surgery, radiography, and anesthesia should be submitted to Dr. Sterling V. Mead, 1149 Sixteenth Street Northwest, Washington, D. C. Articles on oral pathology should be submitted to Dr. Kurt H. Thoma, 47 Bay State Road, Boston, Mass.

TYPES OF RESORPTION OF ALVEOLAR BONE FOUND IN PARODONTAL DISEASE*

KURT H. THOMA, D.M.D., AND HENRY M. GOLDMAN, D.M.D., BOSTON, MASS.

INTRODUCTION

THE object of this paper is to describe the types of bone resorption found in parodontal diseases in fuller detail than has been done previously. The method of resorption in the alveolar bone in these diseases is of extreme importance, and we feel that clues to the etiology will be found in the study of these processes. The material for this study is the same as that used for a previous paper (about sixty-six human jaws obtained at autopsy). The value of this material lies in the fact that the specimens studied are undistorted and have exact relationship of the tooth to the alveolar bone, and the bone can be studied in minute detail.

PART I. BONE FORMATION

Bone is formed directly in a connective tissue framework or membrane, or arises by the replacement of cartilage which itself was formed from connective tissue. Bone is believed to result from the activity of certain cells which arise from an embryonic or adult connective tissue, and which are called osteoblasts. This is questioned, however, by some authorities. The osteoblasts arise directly from mesenchyma or connective tissue cells usually called fibroblasts. As the matrix of the bone is formed, some osteoblasts become incorporated in it, occupying cavities called lacunae, and then are known as bone corpuscles or osteocytes. It is well known that osteoblasts are far more numerous during bone formation than later on, but the fate of the surplus is still undetermined.

Since the jaws develop in membrane we shall discuss the intramembranous method of bone formation. When bone formation is taking place in embryonic connective tissue, a collagenous substance first appears between the branching embryonic connective tissue cells. This is the early matrix which is called

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Fig. 1.—Marginal parodontitis. This is a low power photomicrograph of a case showing pocket formation and bone destruction by lacunar resorption. *D*, dentin; *C*, cementum; *E*, epithelium; *P*, pocket; *CL*, calculus; *B*, bone; *M*, marrow; *R*, round cell infiltration.

Fig. 2.—Marginal parodontitis. This is a high power photomicrograph of the preceding section showing lacunar resorption with the presence of osteoclasts. *C*, cementum; *P*, periodontal membrane; *B*, bone; *TS*, transeptal fibers; *OS*, osteoclast; *R*, round cell infiltration.

interstitial substance. Whether this intercellular substance is a secretion of the connective tissue cells or represents altered portions of the cell bodies is unknown.

While this matrix is forming, some of the cells bordering it differentiate and become known as osteoblasts. Fibers appear in the intercellular substance, and through calcification, true bone results. The osteoblasts which bound the

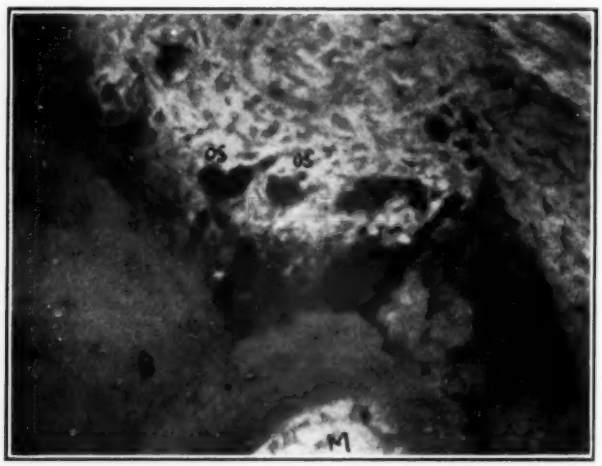

Fig. 3.—Lacunar resorption. The picture shows a high power photomicrograph of lacunar resorption with the presence of osteoclasts. *B*, bore; *M*, marrow; *OS*, osteoclast.

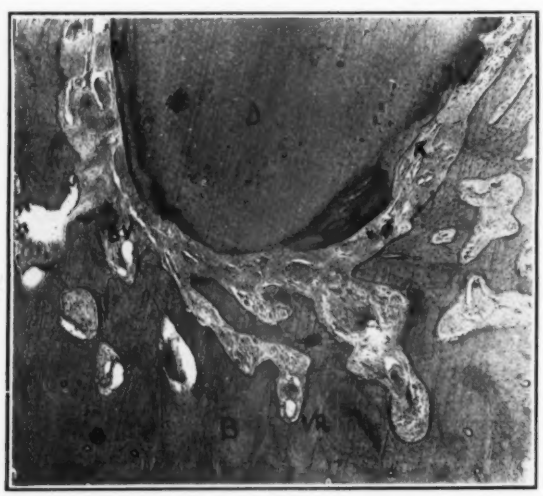

Fig. 4.—Parodontosis. This section shows both bone and cementum destruction by vascular resorption. *D*, dentin; *C*, cementum; *R*, resorption of cementum; *BV*, blood vessel; *C*, bone; *VR*, vascular resorption.

newly forming bone are included in the matrix, and are then called bone corpuscles or osteocytes. Other osteoblasts arise from the surrounding connective tissue and take their place. As the osteoblasts become embedded in the matrix of newly forming bone, they apparently become more highly branched than even the mesenchymal cells from which they arose, and these branches probably give rise to the fine processes which lie in the canaliculi that run from each osteocyte to another. Thus a complete network is formed.

Since fibrillae form in the original amorphous intercellular substance or matrix, all mature bone is fibrous in structure, although it does not seem so, for the inorganic material obliterates these fibrillae.

Since all the bone is first laid down as a framework or spongiosa, it contains vascular connective tissue from which the marrow arises. As soon as the compact bone is formed on the outside of the spongiosa, the connective tissue becomes condensed and is known as the periosteum; a similar thinner membrane lines the large marrow cavities and is called the endosteum.

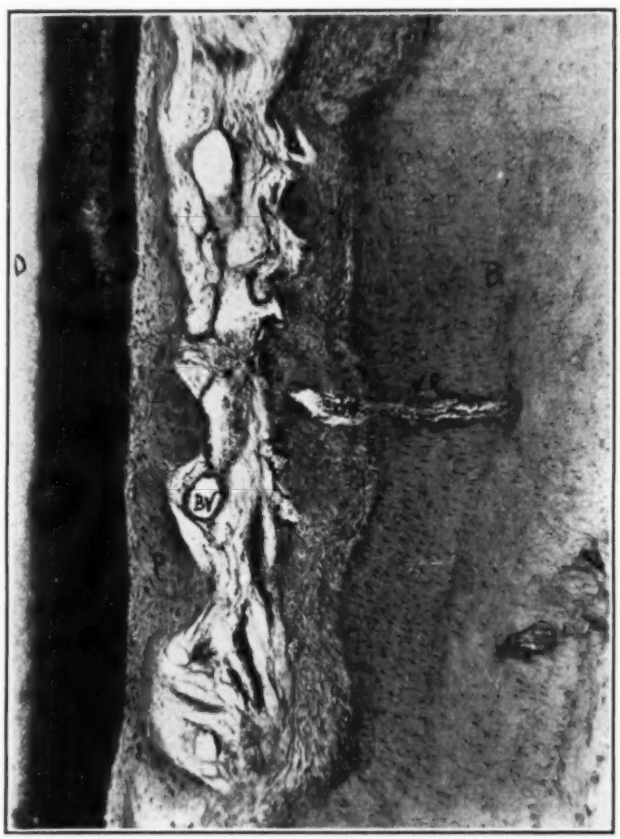

Fig. 5.—Vascular resorption. This section shows a blood vessel entering the bone and resorbing it. *B*, bone; *P*, periodontal membrane; *BV*, blood vessel; *VR*, vascular resorption.

BONE RESORPTION

Resorption of the bone takes place by means of three distinct methods: lacunar resorption or osteoclasis, vascular resorption, and osteolysis or bone reversion.

Lacunar resorption, or osteoclasis, is perhaps the best known method of bone resorption, since more has been written about this type than any of the other phases of bone resorption. Osteoclasts may vary considerably, since both large and small are found. The origin and function of the osteoclast are in great doubt. Some authorities believe that the osteoclast brings about resorption; others think that the osteoclast acts through a secretion of a substance which dissolves the calcium with which it is in contact. A possible diastatic action has also been suggested. All these theories, however, have no absolute proof.

The process of resorption by osteoclasts resulting in the formation of Howship's lacunae is known as lacunar resorption. Howship's lacunae vary in form but generally tend to be hemispherical depressions. They are sharply defined and bounded by apparently normal bone. In or near these depressions, osteoclasts are usually seen, although they may be absent. The osteoclasts may contain few or many nuclei. The large osteoclasts are elongated, flat, multinucleated cells of irregular shape, and have no definite limiting membrane. Their cytoplasm is strongly acidophilic.

Fig. 6.—Vascular resorption. This section shows vascular resorption of alveolar bone alongside the periodontal membrane. *D*, dentin; *C*, cementum; *P*, periodontal membrane; *B*, bone; *BV*, blood vessel; *CT*, connective tissue.

Vascular Resorption.—In this type of bone resorption the bone disappears by the enlargement of the Haversian canals, and by the formation of Volkmann's canals. The marrow spaces are enlarged. Coincidentally with the enlargement of the canals there is a dilation and increase in the number of blood vessels which become extended. The examination shows that the resorption is accomplished by perforating canals in which a blood vessel may be found. This perforating canal seems to cut across the trabecula (Fig. 5).

Osteolysis, or Bone Reversion.—This type of bone resorption is thought by many investigators to be the same process as that of vascular resorption. In bone reversion the inorganic substance of the bone is lost, the bone cells are

liberated and the fundamental fibrous connective tissue network remains. In this process whole trabeculae of connective tissue may be found that were formerly bone. In other instances remains of bone in the center of former bony structure are seen surrounded by the dense connective tissue network. Thus it can be said that bone ceases to be bone, but persists as a connective tissue matrix. It is thought by us that the bone cells once liberated are no longer osteocytes but are fibroblasts.

The marrow in this type of resorption is usually fibrosed. Loose connective tissue is seen. The blood vessels are numerous and are dilated.

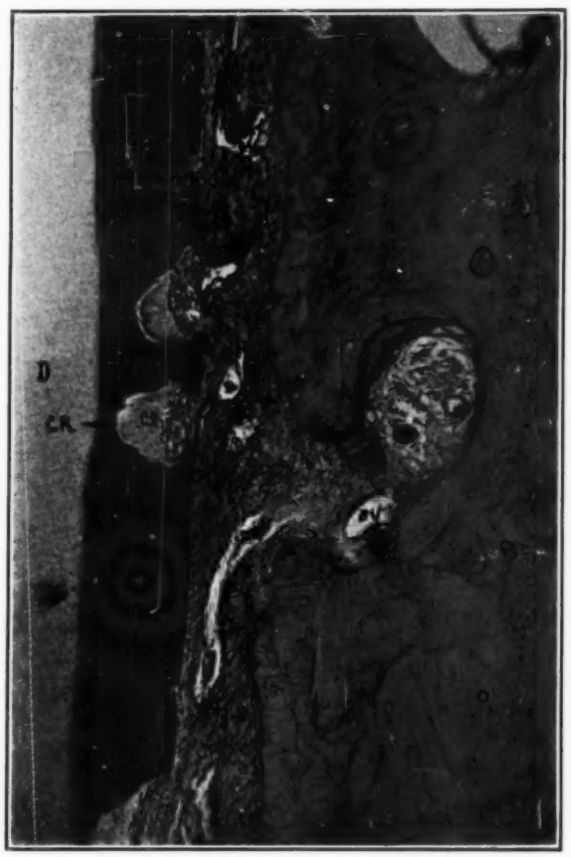

Fig. 7.—Vascular resorption of the alveolar bone and cementum, the cementum being repaired. *D*, dentin; *C*, cementum; *CR*, line to which cementum had been resorbed; *CI*, cementum that has repaired area of resorption; *B*, bone; *BV*, blood vessel.

PART II. RELATION OF TYPES OF BONE RESORPTION

King in his textbook relates the three types of bone resorption in this way: "These three groups are not sharply demarcated from each other, but are frequently to be found in association with each other in pathologic conditions. In the literature not only is one or the other of these emphasized to the exclusion of the remainder but each is described as the mechanism of resorption without recognition being accorded to the compound nature of bone, i.e., an intercellular substance, ossimucin (matrix) and calcium. *In a general way halisteresis*

(osteolysis or bone reversion) is the removal of the calcium; lacunar resorption is the removal of the ossimucin (and incidentally calcium salts). In vascular resorption both ossimucin and calcium are removed usually, but not necessarily in proportional amounts."

It is from this preceding statement that I wish to point out a few facts. Histologic study shows that in *lacunar resorption* all the bone is resorbed at the attacked area, and the fibrous connective tissue that fills in the resorbed area is due to ingrowth from the surrounding connective tissue.

Fig. 8.—Vascular resorption of the alveolar bone and bone reversion. This section shows vascular resorption of the alveolar bone. Varying amounts of ossimucin and inorganic material are resorbed. At *R* the matrix is left, whereas at *VR* both substances are removed. The cementum had been resorbed. New cementum has repaired the defects. *P*, periodontal membrane; *D*, dentin; *C*, cementum; *CE*, cementum that has repaired resorbed area; *B*, bone; *R*, bone reversion; *VR*, vascular resorption.

In *bone reversion* or *osteolysis* whole circumscribed areas of connective tissue are seen which were formerly bone trabeculae, because, with the calcium salts removed, only the framework of the bone persists. This is the process of bone formation reversed, and the network which remains is the matrix which was formed first. It is more cellular, however, because the osteoblasts which, as previously stated, are far more numerous during formation than in formed bone as osteocytes, reappear. Thus it can be seen that bone reversion is demineraliza-

tion of the bone, a process reverse to that of calcification, and the connective tissue that remains is the original connective tissue network of the bone.

King states that in *vascular resorption* both ossimucin and calcium are removed, but not necessarily in proportional amounts. This fact can be demon-

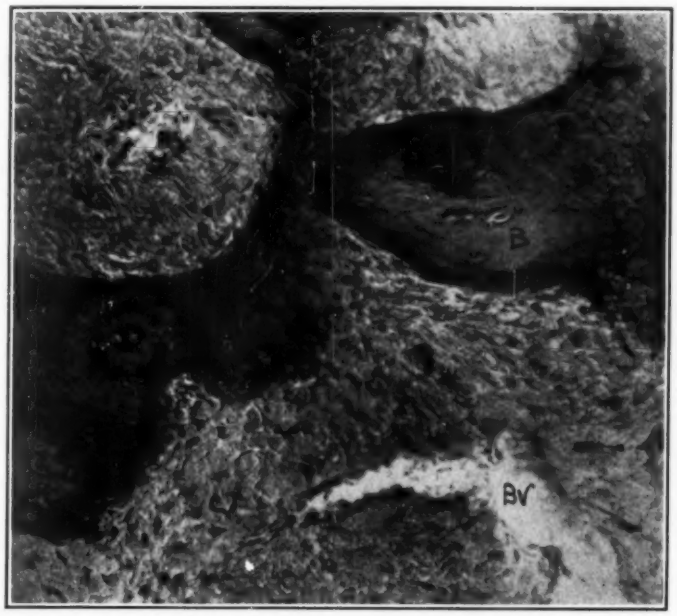

Fig. 9.—Bone reversion. This section shows how the matrix of the bone is left. *B*, bone; *CT*, connective tissue; *BV*, blood vessel.

Fig. 10.—Bone reversion. *B*, bone; *CT*, connective tissue; *BV*, blood vessel. *B* was formerly one whole spicule of bone, now only the center is bone.

strated easily. Sometimes both substances have been removed, and there are cases in which the calcium is removed in excess to that of ossimucin (matrix). The process by which all the calcium is removed we have named reversion. Thus it can be seen that bone reversion is in reality a type of vascular resorption.

PART III

The type of bone resorption found in parodontal disease varies according to the type of the disease. In a previous paper we have classified parodontal diseases into four types: (1) gingivitis, (2) marginal parodontitis, (3) parodontosis, and (4) syndrome of parodontosis and marginal parodontitis. In gingivitis, the bone is not involved; whereas in marginal parodontitis active lacunar resorption is present, with or without the presence of osteoclasts.

Fig. 1 shows a mesiodistal section between a mandibular lateral incisor and a cuspid. In this case the oral hygiene was very poor; deposits were found on all the teeth. Pocket formation was found throughout. Microscopically, we find pockets on each side of the tooth. The epithelium lining the pocket has undergone extensive inflammatory changes, and shows papillary down-growth

Fig. 11.—Bone reversion. The inorganic substance is lost, leaving the matrix. This photomicrograph was taken at the alveolar crest. Pocket formation was present. Round cell infiltration can be seen in the marrow spaces. *B*, bone; *CT*, connective tissue; *BV*, blood vessel in marrow; *M*, marrow.

into the gingival corium. The gingival corium shows evidence of dense round cell infiltration with lymphocytes and plasma cells predominating. The alveolar bone shows evidence of lacunar resorption. In higher magnification, osteoclasts may be seen lying in Howship's lacunae. The bone beneath in the socket is normal; the marrow shows also a normal picture. The resorption of the bone is in a horizontal plane so that the crest of the alveolar bone is gradually reduced.

We found this type of resorption in all the cases of marginal parodontitis. We believe that this type of resorption is evident since the infection and the irritation of the pockets are the cause of the bone resorption, and we believe that if the case is treated and the pockets are eliminated, the resorption would cease and the bone be perfectly normal.

In parodontosis which, we believe, is of systemic origin, the pathology, described in a previous paper, shows that the resorption of the bone is accomplished by vascular resorption and bone reversion. The alveolar bone is attacked before the gingivae are involved, and pocket formation is a later symptom; the bone is resorbed in a plane vertical to the alveolar margin.

The initial lesion in this type is in the alveolar bone around the teeth. Both vascular resorption and bone reversion are evident. Capillaries from the periodontal membrane can often be seen entering into the bone at right angles causing resorption of the bone. Also the cementum of the tooth is sometimes resorbed, and bone reversion may be seen. Connective tissue islands can be found which formerly were bone of the alveolus. All these bony changes are more marked at the apical and crest portions of the alveolus than in the middle. These bone changes occur also away from the teeth and in few cases can be observed in areas in which teeth were missing.

Since the changes of the bone occur most actively at the site next to the periodontal membrane, a widening of the periodontal space results; and it is this widening that is the cause of vertical pocket formation, since the function of the tooth produces too great a strain on the alveolar crest where the transeptal fibers lose their attachment.

When parodontosis is complicated by pocket formation, it is easily understood that local influences enter the picture. Debris and calculus are found in the pocket, and local inflammatory changes result. This results in lacunar resorption of the alveolar bone at the crest. Thus it can be seen that in advanced cases of parodontosis all three types of bone resorption occur, and this of course is also true in the fourth type of parodontal disease which we have called a syndrome, and is simply a combination of marginal parodontitis and parodontosis as described in a previous paper.

CONCLUSION

We have tried to point out in this paper the types of resorption found in parodontal diseases, and their relation to each other. We feel that the clues to the etiology of parodontal diseases will come from the study of these changes in the bone.

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25 Shattuck Street

PROPHYLACTIC ODONTECTOMY OF THE DEVELOPING MANDIBULAR THIRD MOLAR*

A New Operation

C. Bowdler Henry,† M.R.C.S. (Eng.), L.D.S., London, England

AS LONG ago as 1868 Christopher Heath demonstrated the clinical importance of impaction of the mandibular third molar in cases of spasmodic closure of the jaws. An examination of the literature since that year shows an annually increasing number of reports of graver complications associated with this dental abnormality. There is a widespread incidence, and the severity of the complications, amounting to a definite mortality, constantly brings the patients under the care of the general surgeon.

In 456 case reports which I have collected from private sources and from the literature,[1, 2] I find 40 cases of osteomyelitis, 35 of extensive cellulitis and Ludwig's angina, 8 of cavernous sinus thrombosis, 46 of fractured jaw (13 due to external trauma, 21 due to attempted extraction, and 12 to pathologic fractures), 42 cases of cyst formation, and 41 cases of operative accident in which the tooth was pushed into the soft tissues during extraction. Thirty-eight patients died, and there were severe postoperative complications in 68 other cases.

Another important feature is that in 89 cases ineffective treatment for some secondary symptom or lesion was given, often for long periods of time, before the third molar was finally removed, and in 46 cases there was a completely mistaken diagnosis. In one of these the patient, a doctor, was subjected to a gasserian ganglion operation, and in another case a hospital nurse had her mastoid explored and it was found quite healthy. Both these patients lost their painful symptoms when the peccant third molars were found and removed.

It is obvious that this state of affairs constitutes a grave problem for the surgeon. Even under the best possible conditions the treatment of an impacted third molar in an adult cannot be free from risk; and when, as commonly happens, the patients seek extraction only when sepsis is fulminating, the danger of spreading the infection by the trauma incidental to the removal of such a tooth gives added anxiety to these cases. A prophylactic manoeuvre is therefore clearly required, and the operation which I have devised for removing the tooth germ gives the general surgeon the means of dealing with a potential impaction at an age when surgical interference is peculiarly non-traumatic, and at an age, too, when orthodontic correction would not be pos-

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sible and when the extraction of an anterior molar might well be considered as dental mutilation. This operation, however, is essentially one of surgery and not of dentistry, in that it should be conducted in the operating theatre and not in the dental consulting room.

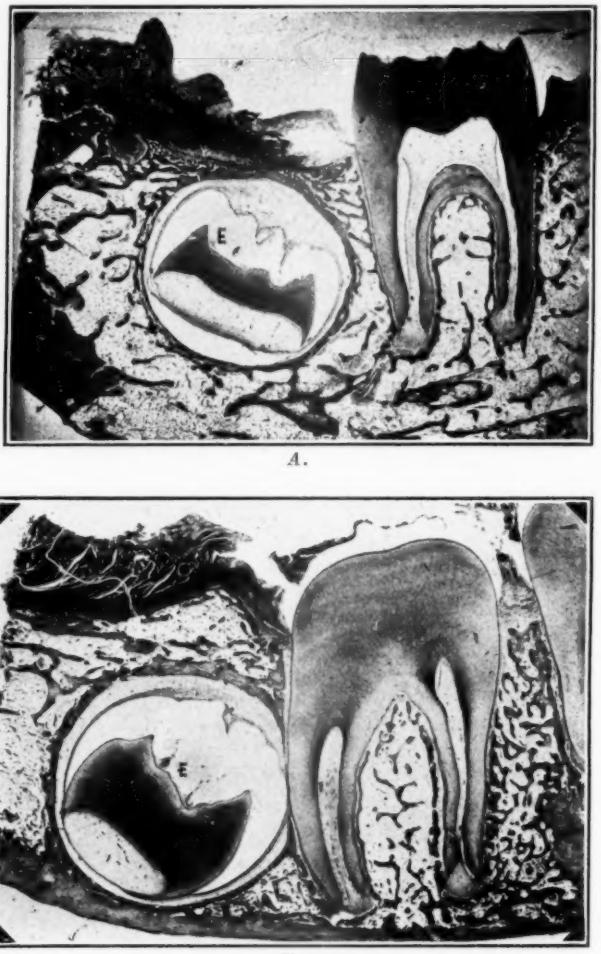
ÆTIOLOGY OF IMPACTION AND SELECTION OF THE CASES

Selection of the cases presents more difficulty than the operation. It is therefore necessary to examine the developmental anatomy of this region in infantile and adolescent jaws and to consider some of the aetiologic factors which predispose to impaction.

Fig. 1.—Photograph and skiagram of the left side of a mandible (dry specimen) of a child of six to seven years old, showing the developing molar teeth. M_1 is erupted, and the crown of M_2 is seen within its crypt. Posteriorly may be seen the early crypt for the M_3 tooth bud, which communicates with that of M_2 by a groove in which lies the connective strand containing the molar extension of the dental lamina.

The permanent or true molars are derived from a backward prolongation of the tooth band behind the germ of the last deciduous molar. This epithelial strand remains upon the surface of the mandible in the region where the alveolar border sweeps upward into the coronoid process. The germs of the three molar teeth are successively formed *pari passu* with the forward growth of the snout which, by carrying the anterior arcade of teeth with it, allows space behind the last deciduous molar for the true molars to erupt, uncrowded by the anterior border of the ascending ramus. At an early stage of forma-

tion, the first permanent molar (M_1) is represented by a bud upon the nether side of this prolongation of the tooth band, and lies in a shallow depression in the superior surface of the jaw. With continued development the germ of M_1 increases in size and becomes more submerged in the bony cell which envelops it. The growing end of the tooth band projects posteriorly to it, and in due course the bud of the second permanent molar (M_2) likewise appears and becomes cradled in a similar depression. Subsequently, repeating the same process, the germ of the third permanent molar, or wisdom tooth (M_3), also makes its appear-



A.

B.

Fig. 2.—Histologic preparations (decalcified, hematoxylin-eosin) of M_2 and M_3 in situ in mandibles of postmortem subjects aged about thirteen years. The spaces marked E are those occupied by enamel of the crowns which has disappeared during decalcification. *A* shows normal development with ample room between the crown of M_3 and the root of M_2. *B* shows crowding of M_3 upon M_2, the root of which, under higher magnification, exhibits osteoclastic resorption of the dentin at the point where the enamel of M_3 impinges upon it. (The author is indebted to Professor B. Gottlieb, University Clinic, Vienna, for the photomicrographs of these specimens.)

ance. Fig. 1 shows the general stage of molar development at six to seven years of age. M_1 has become almost fully formed and has erupted. The crypt of M_2, repeating the developmental stages of M_1, has become submerged by the growth of bone which accompanies its enlargement as the crown of the tooth calcifies. The crypt of M_3 has just appeared and is still superficial.

Further growth of the mandible leads to the submergence of this crypt also, and Fig. 2 shows the anatomic relations at the stage (about thirteen years) when the crown of M_3 is almost fully calcified. In Fig. 2*A* there is ample room for M_3 behind M_2, for between them is a substantial partition of bone, and growth may therefore be considered normal. In Fig. 2*B* there is crowding of M_3 upon M_2 so that the crown of the former, impinging upon the root of the

Fig. 3.—Bilateral skiagrams of the mandibles of three adolescent chimpanzees (♀) showing progressive stages in the formation, rotation and eruption of M_2 and M_3, *pari passu* with the forward growth of the snout. (Specimens M507, C214 and C370 in the Powell-Cotton Museum, Birchington, England. C.B.H. Coll. Nos. 7.309, 7.310, 7.311.)

latter, has actually produced osteoclastic resorption of the dentine of M_2. The angle of M_3 is also significant. In Fig. 2*B* the tooth, owing to lack of space behind M_2, is more inclined toward the anterior molar than in Fig. 2*A*.

The ages at which the buds of M_1 and M_2 make their appearance, calcify and erupt, are remarkably stable; but M_3 shows considerable variation in these respects. In normal children the first visible sign in skiagrams of the initial

depression for M_3 in the surface of the mandible varies between six and eight years, and calcification of the tips of the cusps occurs between seven and eleven years. When the mandibular molars begin to calcify, it is seen that each of them is inclined somewhat forward and also tilted inward toward the tongue. Both the forward inclination and the lingual tilting are more pronounced in M_2 than in M_1, and in M_3 than in M_2. It becomes apparent, therefore, that complete eruption of all three molars in their respective turns is dependent upon concomitant enlargement of the post-lacteon space,* which requires to be sufficient to allow these molars to rotate to a vertical attitude and to emerge in front of the coronoid border. If growth of the jaw should be insufficient, or there should be a premature arrest of skeletal development, rotation of M_3 to a vertical position may indeed take place but the arcade of anterior teeth may not be carried sufficiently far forward to allow this last molar to erupt clear of the ascending ramus, and for this reason the tooth will remain partially erupted, or even buried, although vertical.

The orientation of the developing molar teeth and their successful rotation and eruption *pari passu* with forward growth of the snout are well portrayed in anthropoids in the wild state (Fig. 3). In these animals the normal orientation of each successive developing molar tooth in an early stage of calcification is with its occlusal surface facing directly toward the tongue, and human mandibles sometimes show a similarly extreme degree in the case of the third molar (Fig. 5*D*). In the lower order, however, rotation to the functioning erupted attitude appears to occur easily. Serial skiagrams of developing jaws of these animals show that each molar, as it rotates to the vertical, passes through stages which, were there to be either a foreshortening of the jaw or a premature arrest of growth, would constitute two of the characteristic impactions common to man; viz., the mesio-oblique and the coronoid types. One may assume, therefore, that, other factors being equal, full eruption of the third molar depends upon a sufficiency of forward growth of the lower face providing ample space anteriorly to the ascending ramus. In most modern Anglo-Saxon jaws the space anteriorly to the coronoid border is so much restricted that the third molar finds barely room enough to come through, even when it has succeeded in rotating to the vertical position. Any tendency, therefore, toward further restriction immediately predisposes to impaction. Consequently, as a general rule, subjects showing an extreme of orthognathism are more likely to have impacted third molars than those showing some degree of prognathism in the lower face (Fig. 4).

The size of the teeth also is important. Obviously, in those subjects having mandibles of normal size but with small second and third molars (Fig. 5*C*, the chances of complete eruption are greater than in those whose molars are larger. It is a regrettable fact that the molar teeth have not been reduced in size to accommodate themselves to the phylogenetic shortening of the snout.

*Post-lacteon is the term used by Bolk and others to define the most posterior point on the distal surface of the second deciduous molar. The post-lacteon space is the space between this point and the ascending ramus.

Fig. 4.—The profile photographs and bi-molar skiagrams of two female subjects. The younger one (age twenty-one years) is more prognathous and shows perfect eruption and functioning of all four third molars. The elder one (age twenty-three years and eight months) shows lack of forward growth of the lower face and consequent impaction of both maxillary and mandibular third molars.

Age twenty-three years, eight months.

Age twenty-one years.

Age twenty-three years, eight months.

Age twenty-one years.

Fig. 4.—(See opposite page for legend.)

In jaws of small size, therefore, in which the molar teeth happen to be disproportionately large—and the third molar is sometimes very large—impaction of this tooth is inevitable (Fig. 5*G*).

Another aetiologic factor is found in the trend of conservative dentistry. In an earlier generation the ravages of dental decay played so much havoc with the first molar that often it had to be extracted shortly after its eruption, especially in children of the poorer classes. These molars used also to be extracted even when sound in cases of dental crowding in order "to make room." The effect in such cases was that the second molar, owing to pressure from behind, became tilted over far enough to allow the third molar to erupt even in cases in which impaction might otherwise have supervened. The functional result of this procedure, however, was not found to be good; and consequently the first permanent molars are now conserved, even in the children of the school clinics, with a rigor which amounts to a fetish. But, owing to the insufficient use of radiography, the third molars are mostly overlooked, until at sixteen years and onward their efforts to erupt either cause distortion to the perfect symmetry of the anterior teeth or give rise to pain. This rigid conservation of the anterior molar may be cited as a passive cause of impaction of the third molar; but an active one is seen in some published cases in which M_1 and M_2, having been pushed backward by means of regulating appliances with the object of making space for a crowded second premolar, have so pressed upon the developing third molar as to impact it, when it might otherwise have had room to erupt normally.

Another type of patient in whom impaction of the mandibular third molar commonly occurs is the one whose maxillary M_3 is much reduced in size or is congenitally absent. Growth of the mandible appears to be controlled by growth of the maxilla, and there are many specimens in the Museum of the Royal College of Surgeons showing that, development of the maxilla having been prematurely arrested, because the maxillary third molar either was congenitally absent or was represented only by a mere conical peg, the mandibular third molar, being of normal size, has found insufficient room to erupt and has consequently become impacted.

The present work is based *inter alia* upon a study of the bilateral skiagrams of 500 undergraduates and 600 children taken specially to show the molar regions. It has become apparent from these radiographs that not only those undergoing orthodontic treatment but all children should be radiographed at intervals from seven years of age in order to watch the development of the third molar, so that appropriate measures may be taken to relieve posterior crowding as soon as this condition can be diagnosed. The average age for the occlusal surface of the crown to form appears to be between eight and nine years. At this stage it is possible to judge if the tooth is likely to be grossly impacted, and then relief may be gained by one of three measures: extraction of the first molar, extraction of the second molar, or removal of the developing third molar complete in its follicle. Although sometimes the removal of one of the two anterior molars may be followed by a passable result, in the majority of cases it is to be regarded as a definitely inferior course, for impaction of the third molar is not always averted thereby. Where the facilities exist for removal of the third molar follicle, the best result is undoubtedly obtained by its early enucleation.[3]

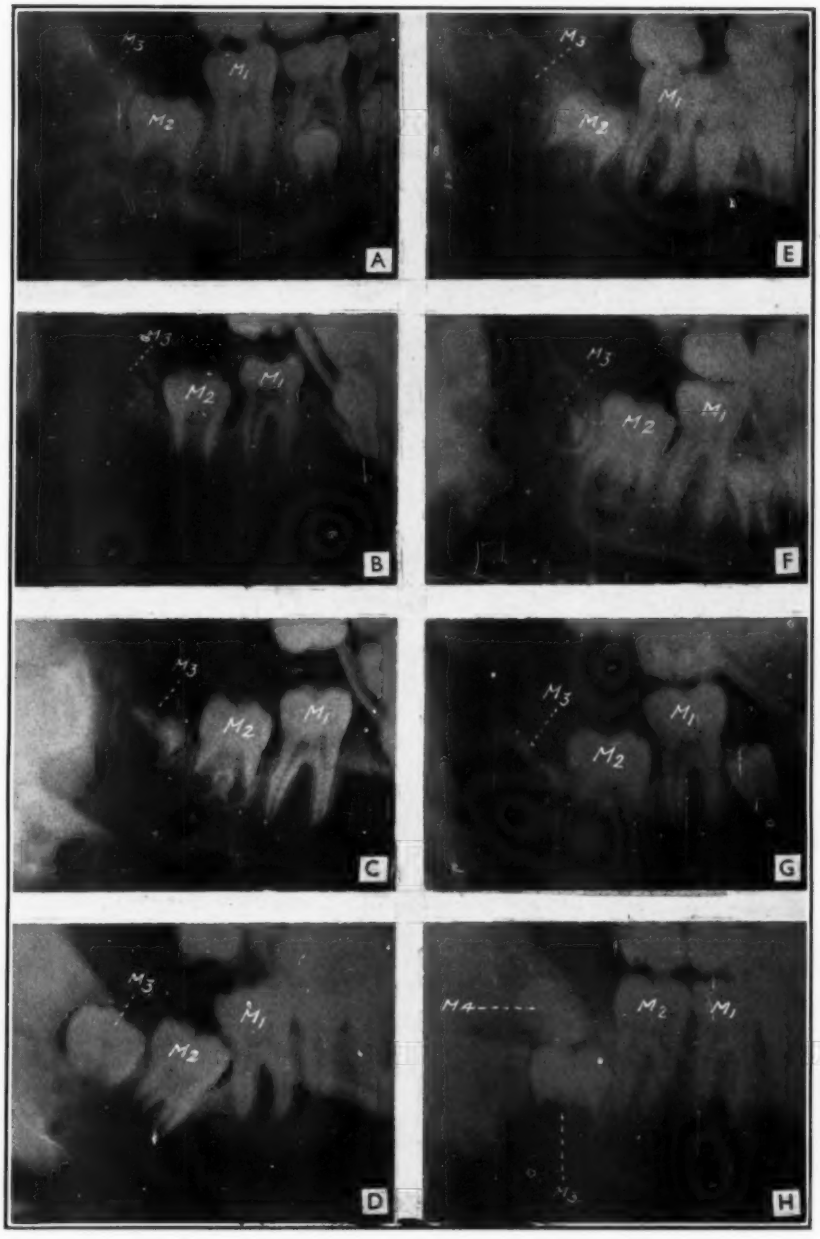


Fig. 5.—Skiagram of the molar regions of children ranging between seven and thirteen years, illustrating the indications for prophylactic enucleation of the M_3 follicles.

Skiagram *A* shows normal development at the stage when the crypt of M_3 is well formed but before calcification of this tooth has commenced. Skiagram *E* shows a similar stage but in a case of molar crowding.

Skiagrams *B* and *F* show cases corresponding to *A* and *E* at the stage when the cusps of M_3 have just calcified. In *B* there is an abundance of room between the three molars, and the tilt of M_3 is not excessive. This case is normal. In *F* the molars are crowded together, the convexity of M_2 lying in the concavity of M_1, the tilt of M_3 is excessive and its impaction inevitable. Cases *E* and *F* are suitable for M_3 enucleation.

Skiagram *C* shows a case of normal development with M_3 of subnormal size and should be compared with skiagram *G* from a patient of the same age in which all the molars are large and crowded upon each other. In *G*, M_3 is too wide in its anteroposterior diameter to erupt, and since its impaction is inevitable, its early enucleation is indicated.

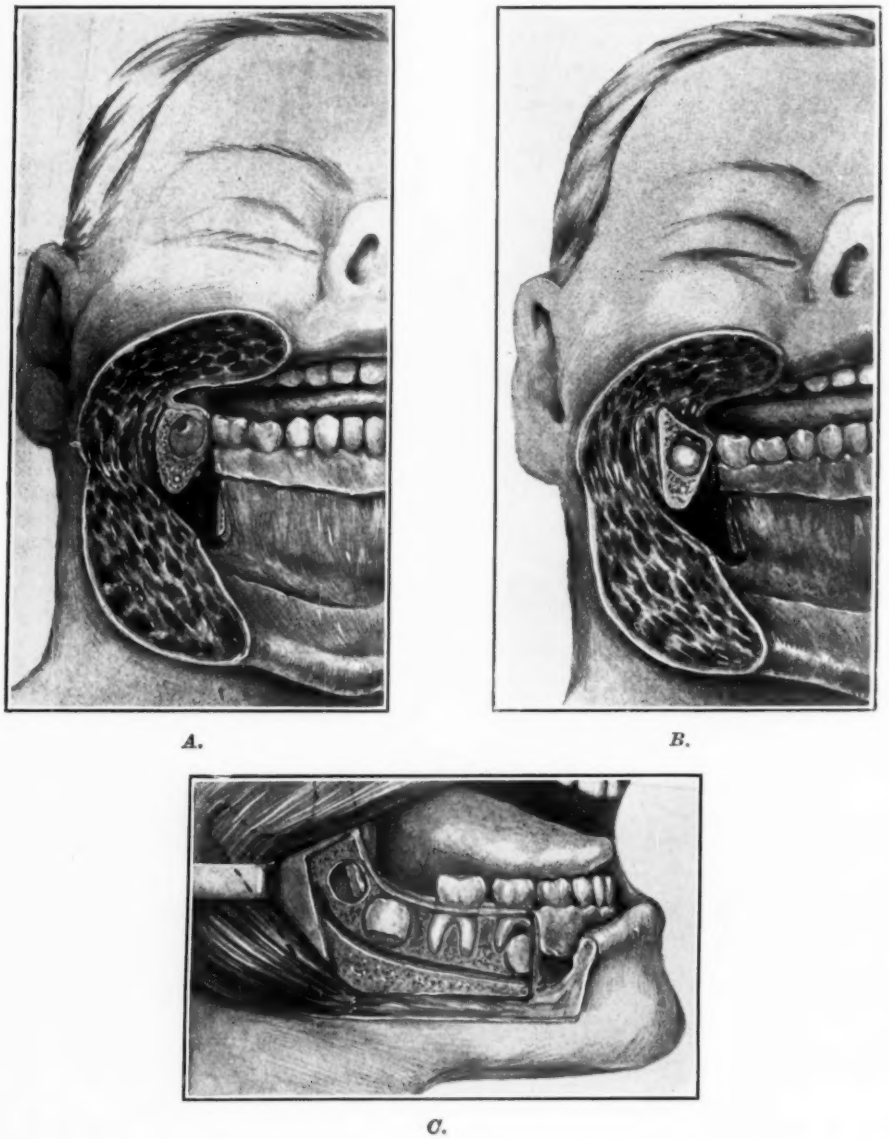
Skiagram *D* shows a case of impaction of M_2 against M_1 and the complete lingual rotation of M_3, which should be removed.

Skiagram *H* shows a case of a well-formed supplementary molar, M_4 developing above M_3 and impacting it. M_4 should be removed.

Both skiagrams *D* and *H* illustrate the value of early radiographic examination. An easier operation with less trauma and a better result might have been expected had these two patients been diagnosed several years earlier.

INDICATIONS

The probable need for surgical interference is first indicated at a time when the germ of the third molar is still small and uncalcified if, as in Fig. 5*E*, the second molar is seen to be developing close under the distal bulge of the first molar. This feature is already indicative of molar crowding (cf., Fig. 5*A*). A case like the one shown in Fig. 5*E* will develop into the one shown in Fig. 5*F*. Although there appears to be no particular disadvantage in waiting



A. *B.* *C.*

Fig. 6.—Drawings made from a dissection of a normal mandible in a child of eight and a half years old.

A shows a vertical section of the mandible made through the crypt of M_2 which has fallen out. The orifice of the channel communicating between this crypt and that of M_3 posteriorly is seen.

B shows a similar section taken one-half inch posteriorly to the one shown in *A*. M_3 is shown in its crypt, the occlusal surface of the crown having just formed.

C shows a lateral dissection of the same region. The outer plate of the mandible has been removed in order to expose the crypts of the developing teeth.

for calcification to begin, to obtain the optimum result the operation should not be deferred any later than this stage. In the earlier stages before calcification has commenced, the contents of the bony crypt consist of a connective tissue follicle joined by a fibrous band to the follicle of the second molar anteriorly and containing a gelatinous mass, which is the dental formative organ, or tooth germ. In a later stage, when calcification has commenced, the cusps of the tooth are first laid down, and these gradually extend laterally and become fused together to form the occlusal surface. Then follows the rest of the crown and ultimately the roots. In its earlier stages the tooth germ is found in a crypt open upon the surface of the bone, its fibrous connection to the follicle of the second molar lying in an open channel (Fig. 1 or Fig. 6*A*). Later, the roof of the crypt closes in, and it becomes much more deeply situated in the body of the bone (Fig. 2 or Fig. 6*B*). As has already been shown, the attitude of the calcifying third molar is almost invariably that of potential mesio-oblique impaction (Fig. 6*C*). It lies with its occlusal surface not horizontal but facing forward and with a definite tilt toward the median sagittal plane. Sometimes, as previously stated, it may show an anthropoid reversion to type and be tipped completely lingually (Fig. 5*D*). Its chances of normal rotation to the vertical and its ultimate eruption depend upon the room at its disposal.

The indications for prophylactic enucleation of the mandibular third molar may be summarized as follows:

(a) In early cases, before calcification of M_3, when the crown of M_2 is crowded against the root of M_1 and when M_3 crypt is sharply tilted behind and above M_2 and crowded upon it. (Compare Figs. 5*A* and *E*).

(b) At a later stage, after calcification of the cusps, when the orientation of the crown of M_3 is seen to be abnormal in either a mesio-oblique direction, as in Fig. 5*F*, or in a lingual direction, as in Fig. 5 *D*, especially when there is further evidence also of molar crowding as shown by M_2 being pressed under the posterior convexity of M_1 (Figs. 5*B* and *F*).

(c) When the molar teeth, and especially M_3, are abnormally large (Fig. 5*G*).

(d) When M_3 (mandibular) is of normal size but M_3 (maxillary) is abnormally small or congenitally absent.

(e) When M_3 is grossly deflected by a supernumerary tooth (Fig. 5*H*).

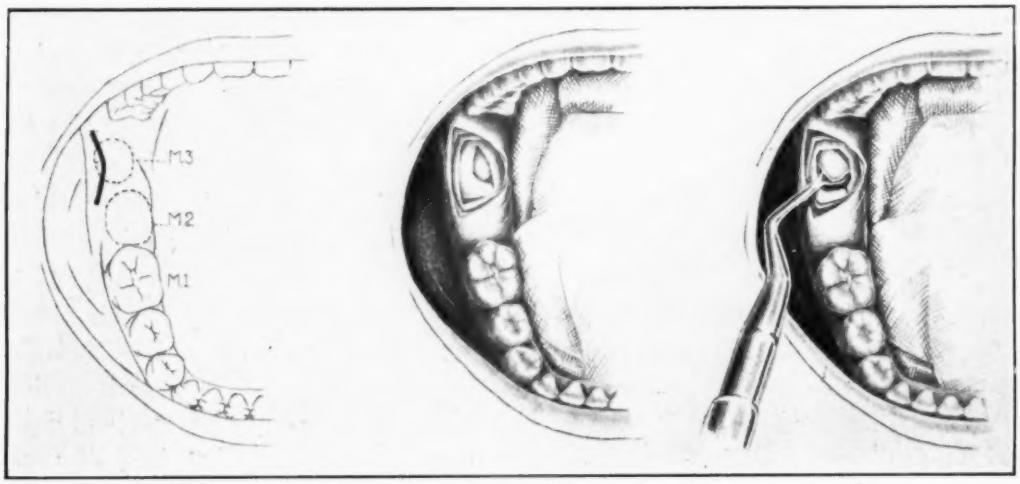
(f) When through the early loss of the deciduous molars, M_1 and M_2 having tilted forward, it is proposed to push these molars backward in order to allow PM_1 and PM_2 to erupt into their proper places.

While some cases are so self-evident that even the laity will see the inadvisability of leaving them untreated, many cases are borderline cases which only experience and judgment will diagnose. The statistical calculations of Dr. G. M. Morant upon the measurements which we have devised[4] may lead to a basis for more accurate assessment of the probability of impaction, when applied to these younger patients and considered along with other factors.

OPERATION

The untoward results of leaving a third molar to become impacted and the evidence of the early stage at which it is possible to prognosticate probable impaction led me to devise the following operation which as a prophylactic measure has everything to commend it and as an operative procedure has nothing to contraindicate it. Indeed, experience shows that the younger the patient, the more readily the bone heals, and much is gained by removing the tooth before it becomes sufficiently large to fill its developmental crypt and certainly before its roots begin to be formed.

Although it is possible to perform the operation under nasal nitrous oxide and oxygen anesthesia or even under block novocaine with suitable premedication, these cases are most conveniently operated upon under endotracheal narcosis. Absolute asepsis is imperative, and for this reason patients cannot be suitably dealt with in a dental surgery; they should be hospitalized. Infection in a crypt may easily lead to osteomyelitis and all its sequelae.



A. *B.* *C.*

Fig. 7.—The stages of operation for the enucleation of a right mandibular third molar follicle. *A* shows the incision on the ascending ramus. *B* shows the integuments retracted and exposing the orifice in the roof of the bony crypt. *C* shows the crypt opened up and the delivery of the calcified mass.

With the mouth open and suitable retractors in place, the vestibulum of the cheek is stretched so as to bring the ascending ramus into prominence. To effect this, a rounded retractor (such as a Frankel tongue depressor) is pushed backward along the buccal sulcus in the mouth to the outer side of the ascending ramus. A slightly curved incision (Fig. 7) is then made, beginning in front at the posterior limit of the tight pad of gum which overlies the second molar and extending for three-quarters of an inch upward. The convexity of the curve should be toward the midline of the mouth. The incision is made deeply to the bone and passes through fibers of the lower attachment of the temporal muscle, sometimes severing a nutrient vessel. The orifice of the third molar crypt is seen at once, and the bone is bared with a narrow raspatory over an area half an inch square. The sides of the wound are held open with toothed retractors, and the roof of the crypt is removed. In young patients the roof is never complete and is as thin as eggshell, so that it can

very easily be removed by hand pressure, or more neatly by light blows on a half inch mastoid chisel with a mallet. Four strokes usually suffice to lift off a square from the roof of the crypt and give ready access. An important point to remember, however, is that rapidity of operation depends on getting the calcified mass out easily. The novice is liable to operate through too small an opening. If the cusps only are calcified, a sharp spoon, shaped like a large dental excavator, readily crushes the occlusal surface; but if the crown is calcified, it will not break and the orifice must accordingly be made very much larger.

The advantage of operating soon after the beginning of calcification is obvious. In the early stages (no later than that of Fig. 5*F*) the crypt is distended almost to its full size but the calcified mass is still small. There is therefore plenty of room between it and the crypt wall for inserting instruments. Later on, the calcified crown fills the whole of the crypt (as in Fig. 5*H*), and its manipulation becomes progressively more difficult.

Fig. 8.—Skiagrams of a case of potential impaction of the third mandibular molar, treated by enucleation of the follicle in a child aged nine and one-half years. *A*, Before operation; *B*, twenty-two months after operation.

When the overhang of the roof has been removed as far as is necessary, a flat spoon is passed down the side of the crypt and its contents are enucleated. Usually the first object to be delivered is a square, firm, pale pink disc, the dentine papilla, which squeezes out. Further curettage either breaks up the calcified mass, which then comes away piecemeal, or delivers it whole. The connective tissue of the follicle separates easily from the bony wall and is removed. The field is kept dry with a suitable aspirator and finally, in case any calcific material and bone débris are left behind, the crypt is flushed with saline.

Formerly I used to suture the wound, but a tendency in some cases to bleed into the tissues and cause swelling of the cheek has led me to leave the wound unsutured and to apply pads of cotton wool on the face under a tight bandage. Any seepage of blood comes out through the wound, which invariably heals by first intention. Provided the case is handled with aseptic precaution, there is no need to introduce antiseptics or plugging.

SUMMARY AND CONCLUSIONS

Probable impaction of the mandibular third molar may be diagnosed from skiagrams in children between the ages of nine and eleven years, and sometimes earlier, depending upon the development of the individual. All children should be radiographed at annual intervals to watch the formation and eruption of these molars. In those subjects in whom insufficient room for full eruption of the third molar becomes evident, it is wiser to enucleate the follicles of this tooth immediately than to leave the case until the tooth has become fully formed and grossly impacted.

The operation is quickly and easily performed. Although the tidying up, if scrupulously done, may take several minutes, the actual removal of the tooth germ should not exceed a minute, and the procedure contrasts most favorably with the difficulty of extracting the same tooth when the crown is formed, and still more when it is deeply buried or horizontally placed with perhaps divergent curving roots. The trauma is less and the patient benefits by losing the tooth at a time when the bone is soft and healing is rapid, and before infection has crept in. Instead of a socket which may take six weeks to heal and give trouble and postoperative pain, the incision of this operation heals by first intention and the crypt is quickly obliterated. There is no disability. The patients are allowed up on the following day. I have now completed 50 cases, comprising 97 enucleations, with no untoward results and without an anxious moment. Fig. 8 shows the skiagrams of a case before and after operation.

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ACTINOMYCOSIS

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CASE 1.—Patient was an Executive of one of America's leading industries. He came to my office in 1931 complaining of pain in the mandibular left second molar region. Clinical and radiographic check-up gave no evidence of the source of trouble. Two months previous to his visit here, his dentist removed a mandibular left second molar. He related the pain to the fact that when the injection was made for the removal of the tooth, the novocaine was injected rapidly, and it gave him a very intense shock at the time. I saw him again a month later, and he was still complaining of the same discomfort. Radiographic and clinical examination gave no evidence of trouble. Again he returned with his face swollen and a shiny glistening edematous area over the masseter muscle. Radiographic check-up gave no clue. He was advised to apply hot poultices. He returned in two days much more swollen. Under nitrous oxide and oxygen anesthesia the area was opened; a small quantity of pus was evacuated and a drain inserted. A week later there was a more intense swelling in the temporal region. This was opened, and a larger quantity of pus was evacuated. The throat on the left side became quite swollen and tumefied, associated with trismus of the mandible. A smear was taken of the pus, and upon examination it proved to be actinomycosis.

The patient became worse and was placed under the care of a dermatologist in New York City. He spent three months in the Vanderbilt Clinic, receiving large doses of x-ray therapy and massive doses of potassium iodide. In the meantime the condition had progressed, involving the corner of his eye and into the region of the scalp on the left side, involving the bone. He convalesced and returned to business, his work taking him all over America. The fistulas healed but his jaw was quite locked; this necessitated his living on a mushy diet. The eye condition never cleared up. The summer of 1937 he developed an ulcer on the eye and was advised to go to the hospital for an operation. He became progressively worse, and remained in the hospital for three months, gradually losing his vitality, and died the latter part of October, 1937.

Upon checking up with him regarding the etiology of the condition, he informed me that each summer he went away to his summer camp and was in the habit of sitting under a tree, reading a book, where cows were pastured, and he often nibbled on the ends of grass. It is quite probable that this fungus was picked up at the time.

CASE 2.—Patient, male, twenty-seven years of age, athletic type, millworker convalescing in Bridgeport from an extraction of the mandibular left second and third molars. Radiographic examination showed two round circular rarefied areas the size of a dime in the third molar region in the body of the bone and in the ramus. The film also showed a devitalized first permanent molar with

diffused area of infection surrounding apices. Examination of the corner of the jaw, externally, showed an indurated swollen area with surfaces bluish red in color with what appeared to be a healed fistula. He informed me that pus had drained from three areas in this region. The infected first permanent molar was removed on the theory that it might be related to the symptoms designated. A week later a swelling appeared in the corner of the outside of the jaw in the area of one of the fistulas.

Upon questioning the young man, he informed me that he kept a cow to provide milk for three young children, and he milked this cow morning and

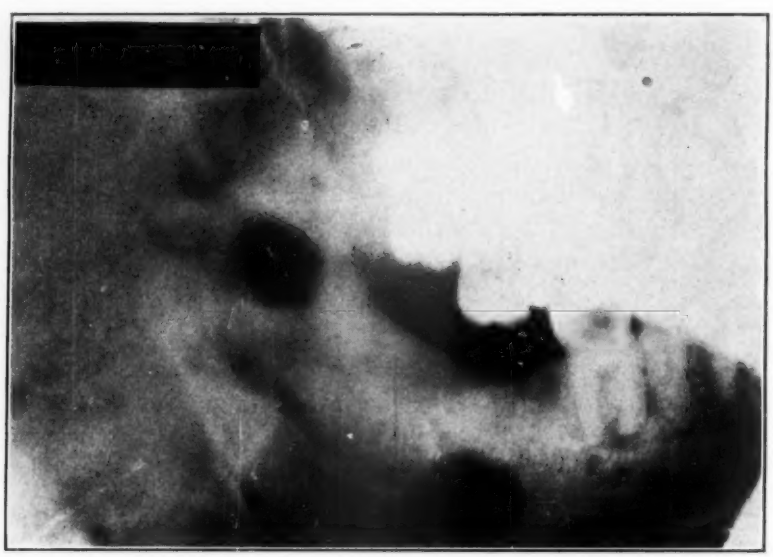

Fig. 1.

evening. A smear was taken and it proved to be actinomycosis. The patient and his relatives were informed as to his condition, and he decided to go back home to Georgia. A few days later I received a letter stating that he was to be operated upon for necrosis of the mandible. I immediately sent word what the diagnosis was. He returned to Bridgeport and I arranged to have a pathologist and roentgenologist treat him. By this time he had failed considerably in body and spirits. A few days later I called the pathologist to inquire for him and was informed that the young man had developed a pathologic psychosis and had been removed to a hospital where he died five days later.

Here are two cases in which one patient received all known modern therapy and the other was not treated for his true condition, and both patients died.

TREATMENT OF COMPLICATIONS ARISING FROM CLEFT PALATE

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A CAREFUL perusal of medical, surgical, and dental literature will reveal that there is an abundance of material pertaining to cleft palate and to cleft lip. As a rule, most of the literature deals with a certain surgical technique or a theory describing the possible etiology of the condition. Other articles attempt a better classification of the various types of abnormalities, and some discuss the pros and cons as to the best time for performing the operation. All this literature is important and contributes to the advancement of our knowledge concerning the subject.

The purpose in this article is to draw the practitioner's attention to the fact that very little literature is to be found which deals with treatment in regard to the future complications which may arise following an operation for cleft palate. The surgical closure of the cleft palate is not the end of the case, in the majority of instances. The development of the child may bring with it, in years to follow, any of the following complications: postoperative fistulas, abnormalities of dentition, speech defects, impacted teeth, and defective facial development.

One often hears of a case in which the parents are well pleased with the successful operation for cleft palate performed on their child. But what despair follows later on when the child attempts to talk and an impediment in speech is detected; or when the parents and friends notice the abnormal development of the upper jaw or the teeth. The facial development is also affected to a certain extent. The growing, developing individual, too, notices that something is wrong, and this often is reflected in his personality.

The following case report deals with some of the cleft palate complications discussed, and the manner in which they were treated.

F. K., white male, aged sixteen years, was of proper build and weight. He presented himself for consultation and examination. I noticed a scar present on the left side of the patient's upper lip. The patient's smile immediately revealed that he was an unfortunate victim of cleft palate, as the anterior part of his mouth was deformed.

A careful intraoral examination showed that this patient had formerly been operated upon for unilateral cleft palate and cleft lip, on the left side. The lip operation had been very successful, except for the remaining scar. The cleft palate was closed, but an opening remained which was about ¼ inch in size, located on the palatal surface, about one inch posterior to the left maxillary anterior area. The patient could not account for the absence of the left permanent central incisor. The maxillary anterior teeth were deformed and out of

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occlusion. There was a gap between the right permanent central incisor and the left deciduous lateral incisor. The patient, therefore, presented a pathetic appearance.

The patient was questioned as to how long he had noticed the opening in the palate. He replied he had been aware of its presence since childhood and that he also had a persistent habit of drawing air through this opening into his mouth. A probe was placed in the palatal opening to determine its source and extent. The probe did not meet any obstruction, and it entered the opening quite deeply. After removing the probe, an intraoral radiogram was made of the anterior palatal surface.

The value and importance of clinical examination in contrast to the radiogram of the case is shown in Fig. 1. The dark circular area above the left central incisor area was not a granuloma or cyst, as was suspected. Surgical exploration of this area later did not reveal any pathologic condition present. Clinical examination showed this to be a fistulous area located about one inch behind the central area on the palatal surface. The small object in the right angle of the picture is a deformed permanent right central incisor. The roots

Fig. 1.

of the deciduous central incisor, lateral incisor, and cuspid were partly resorbed. The impacted permanent cuspid was situated behind the anterior teeth and extended to the lingual surface of the first premolar. The object located in the top of the picture proved to be an artefact, from the developing process.

The diagnosis being completed, it was decided to remove the maxillary permanent right central incisor, the deciduous central incisor, the lateral incisor, the cuspid, and the impacted cuspid involved, and to close surgically the opening in the palate.

The patient was anesthetized with nitrous oxide and oxygen. The palate and the anterior part of the mouth were cleaned with sterile physiologic saline solution, then dried, and sterilized with a solution of merthiolate. The palate was operated on first. A curved curette was inserted into the palatal opening, and the entire tract was scraped thoroughly. The area was then flushed with physiologic saline solution to remove the débris. The bony canal was dried, and sterilized with a solution of merthiolate. The bony canal was again scraped lightly to produce hemorrhage throughout its length, thereby filling it with blood. Pressure was applied with gauze at the palatal opening to stop the hemorrhage. The arch being a high Gothic type, a curved periosteal elevator was

used for sufficiently detaching the mucoperiosteum around the palatal opening so the tissues could be united without any tension. The raw surfaces of the tissues were approximated and united by inserting two interrupted mattress sutures, using for this a curved needle and No. 00 chromic catgut. The mattress suture is preferred for this type of work, as it gives a broader surface for union of the tissues. This part being completed, the anterior part of the jaw was then operated upon.

The outer labial soft tissues were elevated from the maxillary right cuspid area extending to the left second premolar area. The permanent right central incisor, the deciduous central incisor, lateral incisor, and cuspid were removed with forceps. The bony septums between the empty sockets were removed with Rongeur cutting forceps, and the area was cleared of the débris present. This revealed the position of the impacted cuspid. Then sufficient bone was removed to expose the cuspid throughout its entire length. A curved elevator was inserted and the tooth was loosened, thereby removing it through the labial bony opening. The remaining bony areas were smoothed, and were flushed with physiologic saline solution to remove the débris. The area was dried, and surgical bone paste was applied to the exposed bone. Then the remaining cavity was allowed to fill with blood.

The labial soft tissues were then replaced in their position, and a gauze wick dressing was inserted for drainage. The soft tissues were sutured together, using a curved needle and plain catgut. One suture was placed in the right cuspid area, and one each in the central and lateral incisor areas, and another in the left cuspid region. Four sutures were necessary to keep the involved tissues in their proper position. The operated areas were then carefully cleaned. The operation being completed, anesthesia was then discontinued.

After twenty-four hours the gauze dressing was removed. The patient was observed for a week, and then dismissed. No complications developed. The patient was satisfied with the results, especially with the closure of the palatal opening.

Eight weeks after his dismissal, the patient had a partial artificial denture made. This appliance restored the missing teeth and the areas where formerly soft tissue was lacking. This helped to improve his facial appearance. The patient was very grateful, and he had a more pleasant prospect for the future.

This article attempts to show the close relationship of the oral surgeon, the physician, the dentist, and the orthodontist when a case of cleft palate presents itself. Thus we see that these cases may have one or many complications, ranging from a surgical condition to one which may need the combined services of surgery and the dental specialties.

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Materials Used in Dentistry (Einfuehrung in die Werkstoffkunde fuer Zahnaertzte). By Dr. Karl Falk, Professor of Prosthetics at the University of Munich. J. F. Lehmanns Verlag, 1937, Munich.

It is common experience that technical terms used in textbooks on dentistry signify one thing for this person and another thing for another person. Such fundamental terms dealing with dental materials are thoroughly explained in the present volume. The manner of explanation is elementary so that practitioners who have had little training in the subject and less opportunity to study it later on, may read it with as much understanding as the dental student. Furthermore, the presentation was not intended to be complete and elaborate; it should be considered more as an introduction to the subject.

A general grouping divides the subject in two main parts: one dealing with metals and alloys; the other with non-metal materials. The first part begins with an introductory chapter on symbols, specific gravities, and melting points; continues with a most interesting description of the crystalline structure of metals; and carries on with a discussion of alloys, their blending in various proportions, and the changes which occur in their physical properties as a result of different manipulations. Hardness, elasticity, and heat treatment of alloys are explained from a scientific viewpoint and also from the practical angle of a dentist in his laboratory work.

The author devotes some time to the corrosion of metals and alloys; he is of the opinion that the alloys used in one mouth should be alike in composition, otherwise there is always the danger of corrosion. Copper amalgams must never be in contact with gold; silver amalgams only if they are old and completely hardened because newly made silver amalgams have a strong tendency to amalgamate the gold; aluminum and gold are also incompatible in the same mouth. Many times in recent years, the question of poisoning through dental restorations has been discussed in professional and lay circles. Theoretically, all metals are poisons to living cells if used in large enough concentrations. In dental practice, two principal sources of poisoning can be assumed: (1) the incorporation into the body of alloy particles which are ground off a restoration during mastication; and (2) the chemical decomposition of metals through corrosion. To obviate such damage, it is imperative to use

only metals and alloys of great hardness which will not easily give off particles, and also to use only such alloys as will best resist corrosion.

Of special interest to the orthodontist is the chapter on soldering and welding. It is advised to use solders whose composition and melting point are close to those of the precious metal because in this manner a more thorough penetration of metal and solder can take place. If the solder starts flowing at a much lower temperature than the melting point of the alloy, the alloy will not yet be in condition to receive the solder properly. The heat should not immediately be stopped at the moment the solder flows, but should be continued for a few seconds. Later on, heat treatment will further improve the strength of the soldered joint. The welded joint is superior to the soldered one.

The second part of the book deals with non-metallic materials: plaster of Paris, its origin and chemical reactions together with suggestions for practical use; investment materials, studied by means of temperature-expansion charts; impression materials—beeswax, gutta-percha, compound, dentocoll (the problems of sterilization or disinfection of these materials after use is given consideration; from experiments and investigations it becomes evident that it is practically impossible to sterilize them sufficiently for repeated use in the mouth); materials for grinding and polishing; India rubber and the process of vulcanization; porcelain and porcelain substitutes; zinc phosphate and silicate cements. The germicidal value of these cements, even if they contain copper, is questionable; neither is their rôle in the injury and death of underlying pulps sufficiently clarified. The adhesive quality of all cements is not due to stickiness, like that of glue, but to friction created by minute irregularities on the surface of both tooth and inlay (or band). The adhesion is the greater the closer the adaptation of the two surfaces and the thinner the layer of cement between them.

In his presentation Dr. Falk has succeeded in rendering a rather abstract subject readable and interesting. The chapters dealing with the crystalline structure of metals are not only instructive but also fascinating to read. Many materials which the dentist uses every day are brought closer to his understanding by a knowledge of their origin, manufacture, and properties.

Artificial Tooth Crowns (Kuenstliche Zahnkronen). By Dr. Albert Werkenthin. Third part of the author's "Textbook of Dentistry in Five Parts." Gersbach und Sohn Verlag, 1937, Berlin, Germany.

This volume is primarily intended to be a textbook, and the illustrations are arranged in a manner which makes them instructive in themselves. The text is descriptive and the details of construction are easily understood. The book deals with the toothrest left in the mouth after loss of the natural tooth crown; with the technical parts of artificial crowns; with the jacket crown and other porcelain crowns; with crowns consisting of porcelain and metal, and those consisting only of metal; with pin and pivot crowns.

It is the author's objective to make the book complete and uniform in character despite the variety of elements composing it. He uses the historic-

comparative method in his descriptions, acquainting the reader not only with the present status of crown technique but also with the developments which have taken place in this highly limited field within the last fifty to eighty years.

The nomenclature suggested by Dr. Werkenthin is unique and original. He divides the artificial crown in several parts: *a*, the crown body; *b*, the pin or pivot; etc. In the same manner, the material used for the construction of the various parts is marked: α, porcelain; β, porcelain plus metal; γ, metal only, etc. The classification derived from this nomenclature is simple and at the same time descriptive: (1) α + a, α + b, α + c crowns; (2) β + a, β + b, β + c crowns; (3) a + a, a + β, a + γ crowns; and so forth. This eliminates the cumbersome descriptions which are necessary if old names (like Richmond crown with gold crown body) are used, complicated by the fact that the meaning of these terms is not universally uniform.

The scientific character of the presentation is evident in the chapter dealing with the physical properties of crowns and their anchorage to their supporting roots. Careful mathematical calculations are used to determine the force of mastication and the pressure exerted at the various parts of the artificial tooth surface. In conjunction with these calculations, a thorough study is made of the properties of those materials which are used in the construction of the crowns. A generous number of diagrams, tables, and mathematical formulas is provided to take all guesswork out of technical procedures and to supply scientific data and explanation.

An unusually beautiful cover of blue leather distinguishes this volume. The illustrations and diagrams are abundant and clear, and the paper and type are excellent.

Egon Neustadt.

Department of Oral Surgery Abstracts and Reviews

Edited by

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Roentgen Diagnosis and Therapy

Diseases of the Sublingual and Submaxillary Salivary Glands in the Roentgen Picture (Erkrankungen der Sublingual und Submaxillardrüse im Roentgenbild). E. Simon, Zentralbl. f. Chir. **62**: 162, 1935.

In this article the author distinguishes two types of ranula, the true and the false, and describes how these can be distinguished by means of Roentgen examination. He also points out that female patients with cystic degeneration of the salivary glands may have also analogous diseases of the ovaries, the relation being comparable to the occurrence of orchitis (inflammation of the testicles) in mumps.

Before the Roentgen picture is taken, the salivary ducts and the cyst are injected with a radiopaque substance, such as lipiodol. In false ranula there is a separate structure atypical in location, while the true ranula lies in the path of the excretory duct and if injected will also penetrate into the glands so that the entire organ can be demonstrated in the sialogram.

Simon found in one case a connection between all the large salivary glands on one side, with absence of the parotid duct and the presence of a large common duct in the sublingual region.

Roentgen Ray as an Aid in the Operating Room (Röntgenstrahlenhilfe im Operatsionssaal). M. Sgalitger, Arch. f. klin. Chir. **182**: 7, 1935.

The author advises the use of Roentgen control to ascertain the exact position of the needle after its introduction into the foramen ovale in alcohol injection of the Gasserian ganglion, and by injection of a few drops of "jodipin" (20 per cent) to demonstrate where the solution is deposited.

Osteoporosis Circumscripta of the Skull and Paget's Disease. H. H. Kasabach, and A. B. Gutman, Am. J. Roentgenol. **37**: 577, 1937.

The authors record fifteen new cases of osteoporosis circumscripta of the skull and follow-up studies of seven cases previously reported, and present a summary of the roentgenologic, clinical, pathologic, and biochemical characteristics of this interesting affection. They also treat in some detail the relation of osteoporosis circumscripta to Paget's disease, and point out that the maxilla frequently is involved by tumors.

The progress of the disease has been given special attention in this study, patients being under observation from three to thirteen years. Bizarre patterns develop in advanced cases from small, rounded, circumscribed areas of osteoporosis generally in the frontal or occipital regions. Several foci may appear independently, and later may become confluent when generally the entire calvarium is involved.

In 32 of 47 cases in the literature including 11 of the 15 new cases reported by the authors, osteoporosis circumscripta was associated with Paget's disease somewhere in the skeleton. In 18 cases, including 7 of their own, the skull was the site of the osteoporosis circumscripta and had the "cotton-wool" appearance of Paget's disease. In 5 cases of osteoporosis circumscripta of the skull, Paget's disease developed later and was discovered in the follow-up studies. It involved the osteoporotic area or tissue bordering it and developed within two to eight years. It is not believed, however, that osteoporosis circumscripta is an obligatory, early phase of Paget's disease. The authors feel that it is a precursor of Paget's disease or, in a broad sense, an atypical form of Paget's disease as suggested by Sosman. Its occurrence solely in the skull (Paget's disease generally involves other bones also) is thought to be related chiefly to the peculiarities characterizing the diploic circulation and cranial architecture.

The oral surgeon's interest in this study lies in the fact that bony tumors of the maxillary bone were noted in seven cases in the literature, including two presented by the authors. The involvement of the face almost invariably affects the maxilla. These tumors were variously interpreted as osteitis fibrosa cystica, Paget's disease, osteoma, and osteofibroma. It has occurred so often that it is not without significance in the opinion of the authors, and has been commented upon by various writers. Bertel and Provisionato (Stomatol. **32**: 371, 1934) described a case of bony tumor of the right maxilla causing deformity of the face, with osteoporosis circumscripta developing a number of years after the jaw lesion had been present. LeFort and Moreau (Arch. franco-belges de chir. **24**: 7, 1934) presented a case forming an osteoma-like mass in the left maxilla diagnosed roentgenographically as leontiasis ossea. Moore (Am. J. Roentgenol. **10**: 507, 1923) described a case of Paget's disease with bony tumor of the left maxilla and osteoporosis circumscripta of the frontal region. Schüller (Med. Klin. **25**: 631, 1929) saw a case of osteoporosis circumscripta with a tumor of the right maxilla regarded as a questionable sarcoma. Thoma (Clinical Pathology of the Jaws, C. C. Thomas, Springfield, Ill., page 210) described three cases of Paget's disease involving the maxilla. Two showed cotton-wool appearance of this bone, being of the osteosclerotic type. The third case was more osteolytic roentgenographically speaking, showing a mottled appearance of the bone. Whitlock (Radiol. **9**: 153, 1927) described a case interpreted as adamantinoma with changes in the vault thought to be due to extension of the tumor, but which had an appearance thought typical by the authors of osteoporosis circumscripta. One of the authors' two cases was that of a patient first seen for dental examination. A coarse trabeculation of the mandible was noticed suggesting Paget's disease or osteitis fibrosa, and on examination of the skeleton Paget's disease in-

volving the pelvis, entire spine, and both scapulae was discovered. The skull showed osteoporosis circumscripta of the frontal bone. The other patient had a bony swelling of the left maxilla causing a change in the contour of the face. Roentgen examination showed expansion, increased density and coarsened trabeculation, and the diagnosis was osteitis fibrosa or Paget's disease. The biopsy was variously interpreted as osteoma, osteofibroma, and Paget's disease but was finally called osteoma. Films of the sinuses taken later disclosed osteoporosis circumscripta of the frontal bone.

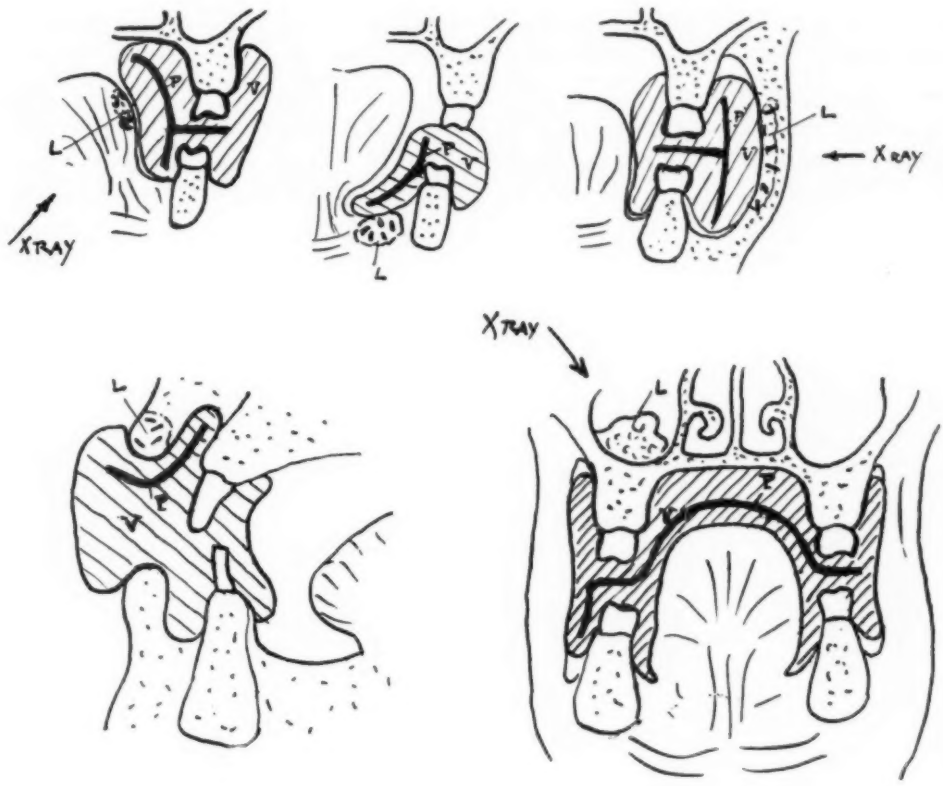

Fig. 1.—Lead shields for x-ray and radium treatment of intraoral cancer described by Ackerman: *V*, vulcanite; *L*, lesion; *P*, lead.

Protective Shields in Radiation Therapy of Intraoral Cancer. A. J. Ackerman, Am. J. Roentgenol. **38**: 746, 1937.

The author points out the truism that in oral cancer success in the treatment by irradiation depends not only upon the destruction of the tumor but also upon the degree to which the harmful effects of irradiation can be limited to the area occupied by it. Protection can be achieved in several ways, particularly the use of the smallest practicable external skin portal, the efficient placement and arrangement of interstitial implants, and the use of protective shields or filters. The paper is principally concerned with the latter subject, which is of great importance on account of the close proximity of several important anatomic structures, particularly the maxillary bones, but also the lips, the tongue, the palate, the cheeks, and the floor of the mouth with the salivary glands.

The construction of such devices requires knowledge of prosthetic dentistry. Ackerman has found that vulcanite rubber is a satisfactory plastic material for the construction of protective shields, especially because it does not emit any harmful secondary radiation. In constructing these appliances a lead sheet one-eighth of an inch in thickness is first cut and shaped to fit over the area to be protected. A layer of softened modeling compound is then placed over this form and inserted into the mouth. The patient is asked to close the jaws until the teeth meet the lead. The compound is then adapted by gentle massage of the cheek and by pressure of the tongue. This may be used if a shield is needed quickly, or for short duration, but generally the compound is replaced by rubber and vulcanized in the regular manner. Many ingenious types of shields are described and illustrated in the article, a schematic representation of these is shown in Fig. 1. The author gives in detail the technical methods for their construction.

Editorial

American Journal of Orthodontics and Oral Surgery

AFTER twenty-three years of publishing articles pertaining to orthodontics, children's dentistry, and oral surgery the INTERNATIONAL JOURNAL OF ORTHODONTIA AND ORAL SURGERY with this issue changes its name to the AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY. This change has been made after careful consideration on the part of the publishers and at the suggestion and with the approval of the editorial staff of the JOURNAL. The name has been altered primarily because the time has arrived when the term *orthodontics* is believed to be more appropriate and comprehensive than *orthodontia.* The term *orthodontia* has become traditional among the workers in this field, and to some people it is somewhat of a shock to change the name of the JOURNAL; however, at this time, there are logical reasons for making this change.

Professor Price, of the Oxford Dictionary Staff and member of the faculty of the University of Michigan, wrote to Dr. G. R. Moore, Chairman of the Nomenclature Committee of the American Association of Orthodontists, as follows: "The term *orthodontia* suggests that it means a flower, a disease, or a city in Asia. *Orthodontics,* on the other hand, is neat in appearance, easy to pronounce, and tells you at once, more or less, what it means. It is on a line with *physics* and *statics* and similar words. The case of *ics* is still more simple. Since the fifteenth century it has been used in English to denote a science. It is a direct translation from the Greek, and we may say that this sort of ending has been used to denote a science for thousands of years. If you speak of *orthodontics,* I know at once that you are speaking about a science and do not need to start guessing wildly in which of half-a-dozen categories I must place this word."

The INTERNATIONAL JOURNAL was launched on its career January 1, 1915, about the time the World War had just gotten under way. Throughout the world the word *orthodontia* was generally used concerning that department of dentistry treating of malocclusion of the teeth. The JOURNAL's first editor, the late Martin Dewey, and the publishers believed that this new specialty of dentistry, *orthodontia,* hardly twenty years old, with only a handful of workers in the field, was destined by sheer merit to assume a conspicuous and important position in health service. After twenty-three years of uninterrupted publication, fortunately that prediction has been amply justified, and the history of the rise and advance of this new specialty has now been permanently recorded in twenty-three volumes of the richest material ever published in any single specialty of dentistry.

The JOURNAL will continue to carry the message of orthodontics into every civilized country of the world; it is believed that AMERICAN JOURNAL is more appropriate because of the close connection between the JOURNAL and the newly formed American Association of Orthodontists. Under its new

name, the AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY will continue in its efforts to publish within its pages material in the interest of the advance of orthodontics and oral surgery. If these specialties of dentistry make as rapid strides in the next twenty-three years as they have in the past same number of years, they will be two of the most highly specialized and flourishing health services for the people in any department of medicine or dentistry. In 1915 when this JOURNAL was started, the going was hard; publication of a journal pertaining to the single subject of orthodontics was pure pioneering and adventure. Good articles were difficult to obtain, and at times it taxed the entire resources of both editors and publishers to secure sufficient material to send the JOURNAL to press each month.

Now all that has changed. Articles are so plentiful on this subject that the problem is mainly how to get the material assembled and edited and before the profession. The JOURNAL, under its old name, is proud of its accomplishments in the publication of such rich material of a new science and art; and had it not been for the loyalty, spirit, and devotion of the workers in this specialty, such an accomplishment would not have been possible. The record of orthodontics as a fast developing specialty of dentistry has been unique, and almost spectacular in its advance. This is no doubt due to the driving urge of its early workers to go ahead. Their energy and loyalty to their work have been nothing short of a religious fervor.

Under its new name, the JOURNAL will keep step with the two specialties, orthodontics and oral surgery, in their steady march to the goal as the two outstanding specialties of the dental profession. The JOURNAL feels that its efforts have been repaid by the fine cooperation and an *esprit de corps* exhibited by these two groups of workers in the advancement of their recorded literature over a long period of years. It feels elation in the pride of accomplishment of what was freely predicted twenty-three years ago to be not only an impossible but also an ill-advised task. It was freely pointed out at that time that orthodontics was purely experimental in scope and character and did not justify a periodical pledged to its advancement as a specialty. The courage of the late Martin Dewey and of Dr. C. V. Mosby proved all those predictions to be false.

The AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY will continue to serve orthodontics and oral surgery throughout the world as it has in the past twenty-three years, and it will continue to cooperate in the fullest measure with the workers in these two outstanding specialties of health service.

H. C. P.

News and Notes

American Association of Orthodontists

The thirty-sixth annual meeting of the American Association of Orthodontists will be held in Los Angeles July 11 to 14. This meeting will be held at the Roosevelt Hotel, which is located within the glamorous center of Hollywood, with its many interests for visitors from other states.

Dr. James D. McCoy, President
3839 Wilshire Blvd.
Los Angeles, Calif.
Dr. Claude R. Wood, Sec'y-Treas.
608 Medical Arts Bldg.
Knoxville, Tenn.

Rocky Mountain Midwinter Dental Meeting

The annual meeting will be held at the Shirley-Savoy Hotel, Denver, January 9-12.

Dr. Albert P. Horton, General Chairman
206 Metropolitan Building
Denver, Colo.

Section of Dentistry and Oral Surgery of Pan American Medical Association

The Section will participate in the Seventh Cruise-Congress, on the "Queen of Bermuda," leaving New York January 15, and returning January 31. The Cruise-Congress is scheduled to be in Havana on January 18-23, at Port-au-Prince on January 24, at Trujillo City on January 26, and at San Juan on January 27.

The Cruise-Congress will provide most attractive winter vacation. In addition to the excellent opportunities for social activities, there will be a program of papers and clinics by dentists and papers by physicians to be presented at general assemblies, and round table discussions aboard ship. Physicians and dentists residing in the countries visited will be entertained at luncheons aboard ship.

Dr. Alfred Walker, President
501 Madison Avenue
New York, N. Y.

Harvard Society of Orthodontists

The semiannual meeting and dinner of the Harvard Society of Orthodontists will be held at Vanderbilt Hall, 107 Louis Pasteur Ave., Boston, on January 12, 1938, at 6:30 o'clock.

All ethical members of the dental and medical professions are cordially invited.

Dr. Harold J. Nice, Secretary
475 Commonwealth Avenue
Boston, Mass.

Dallas Midwinter Dental Clinic

The eleventh annual meeting of the Dallas Midwinter Dental Clinic, sponsored by the Dallas County Dental Society, will be held at the Hotel Adolphus, Dallas, Texas, January 17, 18 and 19, 1938.

Four outstanding, nationally known clinicians will conduct the courses: Dr. C. W. Hoffer, Nashville, "Restorative Dentistry, Including Inlay and Crown Bridge Technique"; Dr. Claude Cannon, Fayette, Alabama, "Manipulation and Insertion of Amalgam, and Amalgam as a Filling Material"; Dr. John W. Seybold, Denver, "Dental Infections as a Factor in Systemic Disease"; Dr. Edward B. Spalding, Detroit, "Principles of Partial Denture—Design and Construction."

A card showing membership to American Dental Association will be necessary for admission to these sessions. For additional information, write Dr. T. A. Lipscomb, 1614 Medical Arts Bldg., Dallas, Texas.

North Atlantic Orthodontic Society

The next meeting of the North Atlantic Orthodontic Society will be held in the Hotel Pennsylvania, New York City, on Wednesday afternoon and evening, January 26, 1938, starting at 2 P.M. All members of the profession are most cordially invited to be present.

DR. EDWARD A. LUSTERMAN, Secretary
185 West End Avenue
Brooklyn, N. Y.

International College of Dentists

The next annual meeting of the International College of Dentists, United States Section, will be held at the Stevens Hotel in Chicago, February 13, 1938.

DR. ELMER S. BEST, Registrar
801 Medical Arts Bldg.
Minneapolis, Minn.

Southern Society of Orthodontists

The sixteenth annual meeting of the Southern Society of Orthodontists will be held at the Hotel Cleveland, Spartanburg, South Carolina, on February 7 and 8, 1938. All ethical members of the dental and medical professions are cordially invited.

CLYDE O. WELLS, President,
828 Montgomery Building,
Spartanburg, S. C.

WILLIAM P. WOOD, JR., Secretary,
442 W. Lafayette Street,
Tampa, Florida.

Eastern Association of Graduates of Angle School of Orthodontia

The annual meeting of the Eastern Association of Graduates of the Angle School of Orthodontia will be held at the Boston Medical Library, Boston, Mass., on Monday and Tuesday, January 24 and 25, 1938.

DR. E. SANTLEY BUTLER, Secretary
55 Locust Avenue
New Rochelle, N. Y.

North Carolina Dental Society

The sixty-fourth annual meeting of the North Carolina Dental Society will be held at the Robert E. Lee Hotel in Winston-Salem, N. C., May 2-4, 1938. All members of the American Dental Association are cordially invited to attend.

FRANK O. ALFORD, Sec.-Treas.,
1109 First National Bank Bldg.,
Charlotte, N. C.

Thos. P. Hinman Midwinter Clinic

The twenty-fourth annual session of the Thos. P. Hinman Midwinter Clinic will be held at the Biltmore Hotel, Atlanta, Ga., March 14 and 15, 1938.

Southwestern Society of Orthodontists

The eighteenth annual meeting of the Southwestern Society of Orthodontists will be held at the Adolphus Hotel, Dallas, Texas, March 6-9.

Dr. Oren A. Oliver and Dr. Hermann T. Becks will be the leading essayists.

All members of the American Association of Orthodontists are cordially invited to attend.

DR. HARRY H. SORRELS, Secretary
Medical Arts Building
Oklahoma City, Okla.

Five State Post Graduate Clinic

The District of Columbia Dental Society will conduct the Five State Post Graduate Clinic on March 6-9 at the Mayflower Hotel, Washington, D. C. This year the Committee has arranged a scientific clinic to conform to the principles on "Dental Health for American Youth" advanced by the president of the American Dental Association.

The following men will present papers: Dr. Malcolm W. Carr of New York; Dr. Oscar V. Batson, Graduate School of Medicine, University of Pennsylvania; Dr. Albert J. Irving of New York; Dr. Lon Morray of Chicago; Dr. Alexander H. Patterson, Professor of Prosthetic Dentistry, University of Maryland.

The afternoon of March 7, a reception will be held from 5 to 7 o'clock in honor of Dr. C. Willard Camalier, president of the American Dental Association.

DR. JOHN P. BURKE, President
Colorado Building
Washington, D. C.

Dental Society of State of New York

The seventieth annual meeting of the Society will take place May 10-13 at the Hotel Syracuse, Syracuse, New York.

DR. EDWIN I. HARRINGTON, President
Woolworth Building
Watertown, N. Y.

Mexican Association of Orthodontics

The first Medicodental Convention of the Mexican Association of Orthodontics will be held in Mexico City February 14-20. The object of the meeting is to gather together physicians, surgeons, dental surgeons, and orthodontists, both national and foreign, in order to derive from the resulting interchange of ideas the greatest possible benefits for the advancement of the respective specialties.

During the convention there will be lectures, surgical operations, clinical demonstrations, exhibitions, and moving pictures, by prominent members of the various branches of medicine and dentistry.

A delegation of American specialists will lecture on cancer, otorhinolaryngology, plastic surgery, orthodontics, pyorrhea, prosthesis, endocrinology, and pediatrics.

The following orthodontists will attend the meeting: Spencer R. Atkinson, George W. Hahn, Glen Terwilliger, J. A. Linn, B. Holly Broadbent, George Grover, and George Chuck.

DR. S. FASTLICHT, Secretary
Madero 40, Desp. 102
Mexico, D. F.

Note of Interest

Dr. Alba Lee Massey announces the removal of his offices to Speedway at Second Avenue, Tucson, Arizona. Orthodontia exclusively.